FEB 19 1947

Vol. 105
No. 2720

Pages 163-190

February 14, 1947

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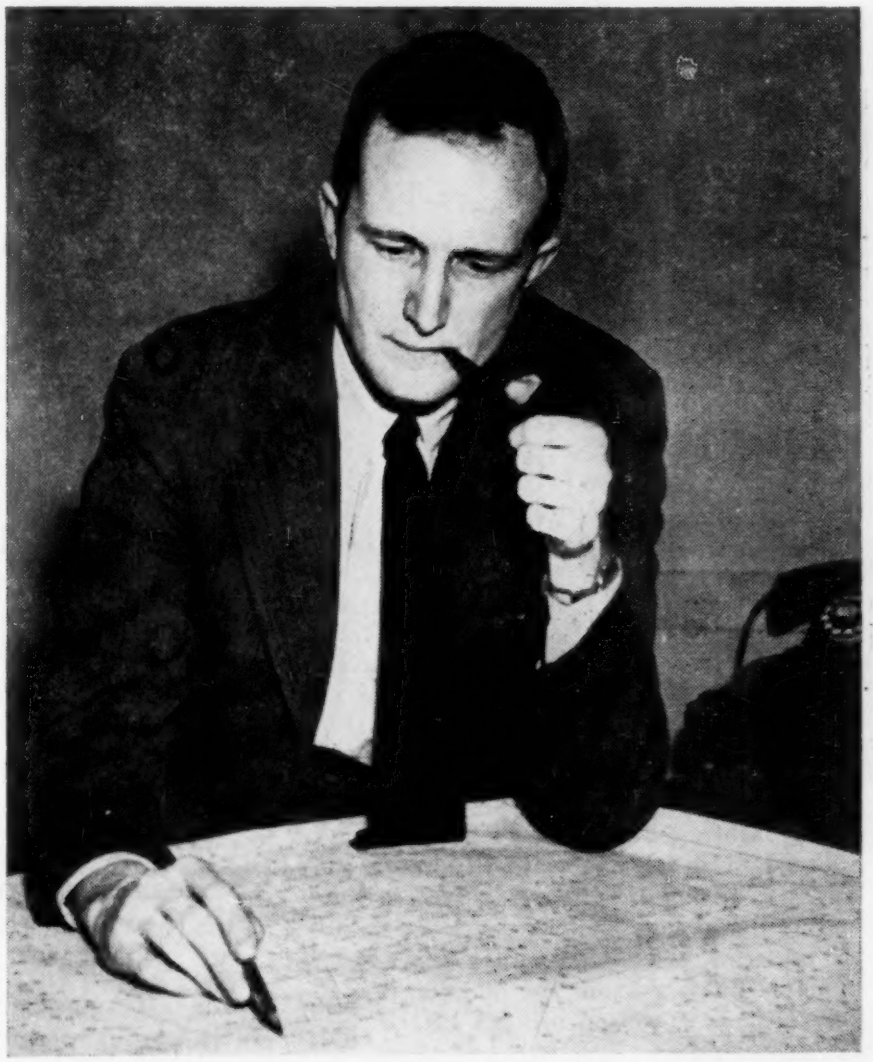

James B. Fisk, formerly assistant director of physical research, Bell Telephone Laboratories, who resigned on February 1 to become director, Division of Research, Atomic Energy Commission. Dr. Fisk joined the Bell staff in 1939 after a year as associate professor of physics at the University of North Carolina. After receiving his B. S. degree in 1931 and his Ph.D. in 1935 from Massachusetts Institute of Technology, he did postdoctorate work at Harvard and Cambridge University, England.

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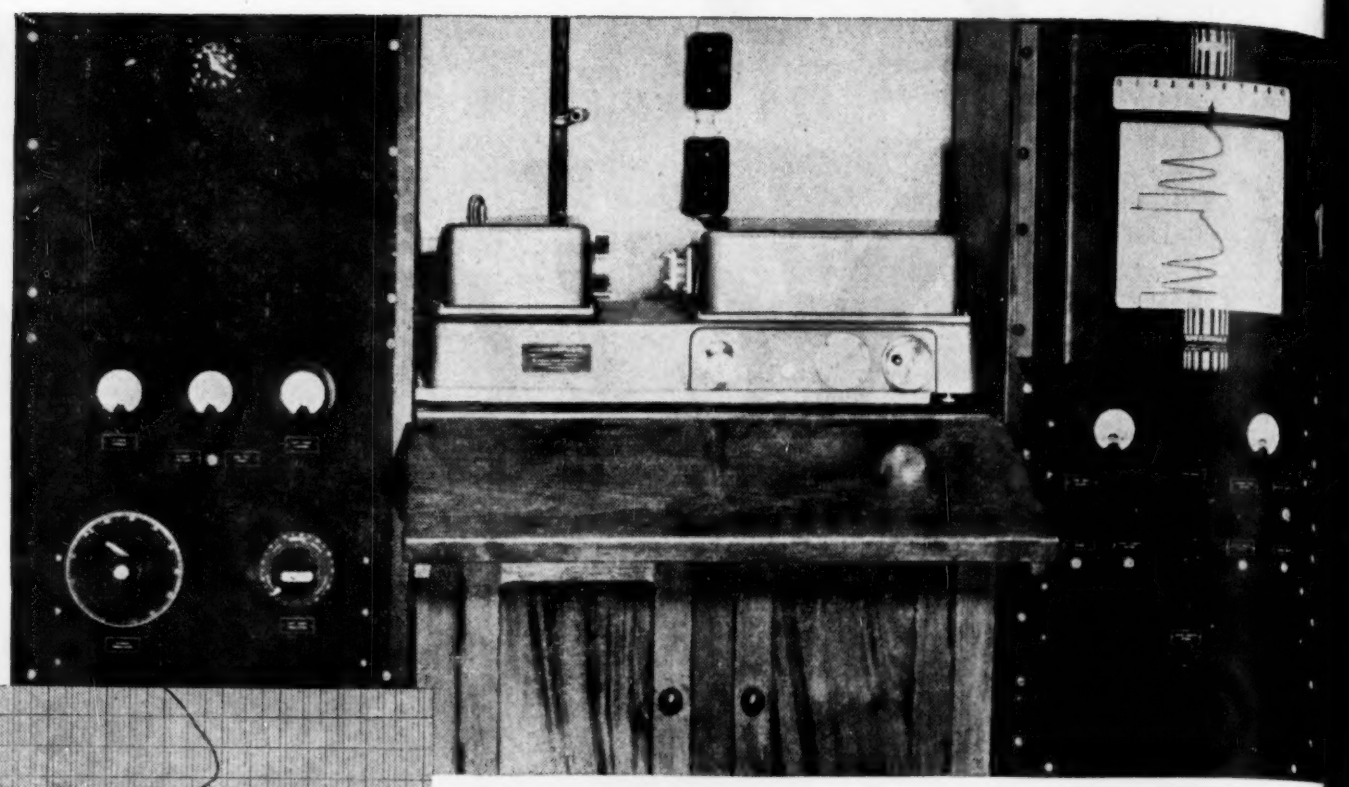
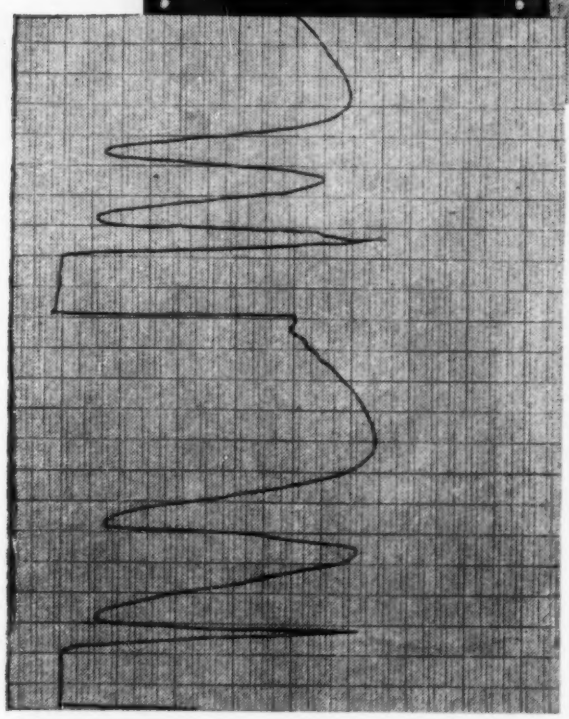
Harlow Shapley: President of AAAS, 1947

Otto Struve





At top: Infra-red spectrometric equipment at Standard Oil Development Co. Speedomax Type G, in upper right panel, records the output of the Perkin-Elmer spectrometer in the center of the photograph. Pre-amplifier mounted directly under the Speedomax is a galvanometer type and uses an L&N Type HS galvanometer.

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Science

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(Cover photograph by Press Association, Inc.)

Science, a weekly journal, is published each Friday by the American Association for the Advancement of Science at Mt. Royal & Guilford Avenues, Baltimore 2, Maryland. Founded in 1880, it has been since 1900 the official publication of the AAAS. Editorial, Advertising, and Circulation Offices, 1515 Massachusetts Avenue, N.W., Washington 5, D. C. Telephone, EXecutive 6060 or 6061.

Articles offered for publication should be sent to the Editor, 1515 Massachusetts Avenue, N.W., Washington 5, D. C.

Membership correspondence for the AAAS should be sent to the Administrative Secretary, 1515 Massachusetts Avenue, N.W., Washington 5, D. C.

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Entered as second-class matter July 18, 1923, at the postoffice at Lancaster, Pennsylvania, under the act of March 3, 1879. Re-entered as second-class mailing matter under the act of March 3, 1879, January 17, 1947, at Baltimore, Maryland.

Association Affairs

Harlow Shapley: President of AAAS, 1947

Otto Struve, *Director,*
Yerkes Observatory, University of Chicago, and
McDonald Observatory, University of Texas

ABOUT A YEAR AGO IT WAS MY PRIVILEGE to accompany Dr. Harlow Shapley to an international conference of astronomers at Copenhagen. At the Shannon airport in Eire, which is rapidly becoming a meeting place of transatlantic airline passengers from all over the world, we noticed among the large crowd in the waiting room a gentleman whose face looked vaguely familiar. An attendant furnished the information that "he is our own Dev, like whom there is no other man on earth." Since we were being delayed by bad weather and Mr. Eamon De Valera was apparently in no great hurry (he was waiting to receive the three newly-created American cardinals, on their way from Rome to the United States), Dr. Shapley arranged for an introduction, and a few minutes later he had in his pocket an outline for the joint operation in South Africa of an Eire-Ulster-Harvard photographic telescope of the Baker-Schmidt type. The formal announcement of the agreement joining together the Armagh Observatory in Northern Ireland (with E. Lindsay as the director), the Dunsink Observatory of Dublin, and the Harvard Observatory was made by Dr. Shapley last September at a meeting of the American Astronomical Society in Madison.

This incident is characteristic of the new president of the AAAS. Problems of international cooperation in science have taken him to Russia and to India, to Mexico and to Great Britain. He was one of the American scientists most active in the organization of UNESCO, and he proposed to that body—as one step toward the internationalization of science—that a new international observatory be created in a favorable location, perhaps south of the equator, where astronomers of all nationalities could work and collect observational material.

Dr. Shapley's own scientific work began almost 40 years ago, when, as a student of F. H. Seares at the University of Missouri, he started a series of photographic observations of eclipsing variable stars. The high precision of this work brought him to the attention of H. N. Russell, at Princeton, and in 1912 Shapley was awarded a fellowship at that University. His doctor's thesis, which was devoted to the discussion of the orbits of 90 eclipsing binaries, forms the most significant single contribution toward our understanding of the physical characteristics of very close double stars.

Shapley's next, and perhaps greatest, scientific work was carried out at the Mount Wilson Observatory. In some respects it created a revolution in scientific thought that was analogous to the revolution set off by Copernicus. From his studies of closely-knit star groups, which are designated as globular star clusters, Shapley concluded that the galaxy is enormously larger than had previously been thought probable. He boldly abandoned the geocentric system of the galaxy which had been proposed by earlier workers, and proved conclusively that the solar system is located near the outer fringe of the stellar system. His determination of the angle of longitude, along the Milky Way, at which the center of the galaxy is seen from the earth yielded a value of 325°, and this number has assumed a significance to astronomers quite similar to that which the number 3×10^{10} cm./sec. carries to physicists.

In 1921 Shapley became director of the Harvard Observatory, as successor to E. C. Pickering. His own work during the past 25 years has been devoted largely to studies of the distribution of galaxies in "metagalactic" space. As an administrator, he has set a new high in the quality and quantity of the research work of his observatory. He wisely continued the policy of his predecessor in concentrating upon great projects like the classification of several hundred thousand stellar spectra or the cataloguing of vast numbers of exterior galaxies; but he also encouraged individual research and brought to Harvard some of the most brilliant research workers in astrophysics and stellar astronomy.

Since the beginning of the war Shapley has been devoting a large part of his time to the broader problems of the organization of science and the preservation of our civilization throughout the world.

No doubt all astronomers sometimes experience a feeling of regret that even a small fraction of the mental energy of so brilliant a research worker should be lost to astronomy. But they must recognize that Dr. Shapley is fighting a battle for all science. His election as president of the AAAS is a symbol of the overwhelming support which American scientists are prepared to give him in his courageous effort to advance world peace.

Anesthesia's Second Power:

Probing the Mind

Henry K. Beecher

Dorr Professor of Research in Anesthesia, Harvard University, and
Anesthetist-in-Chief, Massachusetts General Hospital, Boston

WHEN SIR HUMPHRY DAVY WAS only 20 years old, he made a remarkable study of nitrous oxide. On the basis of his own experiments he not only recommended that nitrous oxide be used for the relief of pain in surgical operations, but he also realized that by breathing this agent it had been possible for him to get at levels of his mind not ordinarily accessible. But let young Davy tell what happened the day after Christmas, in the year 1799.

I felt a sense of tangible extension highly pleasurable in every limb; my visible impressions were dazzling and apparently magnified. I heard distinctly every sound in the room and was perfectly aware of my situation. I lost all connection with external things; trains of vivid visible images rapidly passed through my mind and even connected with words in such a manner, as to produce perceptions perfectly novel. I existed in a world of newly connected and newly modified ideas. I theorified; I imagined that I made discoveries. When I was awakened from this semidelirious trance by Dr. Kinglake, who took the (gas) bag from my mouth, indignation and pride were the first feelings produced by the sight of the persons about me. My emotions were enthusiastic and sublime; and for a minute I walked about the room perfectly regardless of what was said to me. As I recovered my former state of mind, I felt an inclination to communicate the discoveries I had made during the experiment. I endeavored to recall the ideas, they were feeble and indistinct; one collection of terms, however, presented itself: and with the most intense belief and prophetic manner, I exclaimed to Dr. Kinglake, "Nothing exists but thoughts!—the universe is composed of impressions, ideas, pleasures and pains!"

(Those who are familiar with the history of philosophy will recognize that this is the epitome of that extraordinary school set forth long before this time by Bishop Berkeley.)

I have quoted this experience of the young Davy in some detail, for it appears to be the first recorded example that modern anesthetic agents give possibility of planned access to levels of consciousness not ordinarily attainable, except perhaps in dreams, in trances like those of the poet Tennyson, or not uncommonly in the reveries of true mystics, dealt with in such detail by William James. But dreams, trances, and mystical utterances are subject to the caprice of unknown factors, hardly suitable for methodical investigation. On the other hand, Davy had stumbled upon a quality of anesthetics that holds much of potential value for mankind and has already given a good deal by way of practical result in this field. The potential value, besides the proven worth of anesthetics in dealing with problems of the mind, is great enough to allow speculation.

It was not until 60 years after Davy and 14 years after Morton, in 1860, that another young man, one Benjamin Blood, aged 28, in the unlikely spot of Amsterdam, New York, apparently then without knowledge of Davy, had a like experience on recovering from ether anesthesia. Perhaps because Benjamin Blood was of a more philosophical nature than Davy, or more likely because he did not have so many other things pressing him, he became consumed by curiosity concerning this phenomenon and devoted 14 years to its study before publishing privately his first paper on the subject ("The anaesthetic revelation," 1874).

By "anaesthetic revelation" Blood meant "...a certain survived condition...of an appreciation of the genius of being...(which) cannot be formally remembered" on awakening from anesthesia. Further experimentation convinced him "...that there is an invariable and reliable condition...ensuing about the instant of recall from anaesthetic stupor to sensible observation, or 'coming to', in which the genius of being is revealed but because it cannot be remembered in the normal condition it is lost altogether,...and buried, amid the hum of returning common sense, under that epitaph of all illumination: 'this is a queer world.'" Undiscouraged, Blood probed with anesthetic levers into his subconscious and into that of his friends for 14 years and was the first to attack this problem deliberately with modern anesthetic agents.[1] He struggled to develop anesthetic tools to get at the memories hidden in the subconscious, 70 years before they became effective instruments and 80 years before they were widely employed for narcoanalysis in the recent war.

Based on an address delivered at the celebration of the 100th Anniversary of the First Public Demonstration of Surgical Anesthesia, Massachusetts General Hospital, Boston, October 16, 1946.

[1] Alcohol, opium, hashish, and many other drugs had been known for centuries as effective in releasing certain dreams and phantasies. The use and value of hypnosis in dealing with problems of the mind had been known, also for a long time.

Somehow Blood's work fell into the hands of William James, who, besides his other accomplishments, organized the first psychology laboratory in America in 1875. It would be impertinent of me to appraise the quality of William James. Others better able to do so have said he is one of the two greatest and most original thinkers this country has produced. James's comment on Blood's paper was: ". . . I am conscious of its having been one of the stepping stones of my thinking ever since (reading [illegible])."

Then followed a lively period of human experimentation using the tool of anesthesia to probe the subconscious. (This foreshadowed, of course, one of the important medical applications in World War II.) This work was led by William James in this country and by Sir William Ramsay in England. Primarily, at that time, it was the philosophers rather than the physicians who were interested in this use of anesthetics.

This at times rather tenuous trail from 1799 to the present is marked by what appear to be repeated independent discoveries, an ever-new awareness of still unanswered needs. Whether the next important steps were influenced by Davy or Blood or James is not clear. In any case, they offer an excellent illustration of the sardonic truth that accidental findings oftentimes outreach things sought.

It seems natural in treating excited, hyperactive individuals that sleeping pills and anesthetics would be employed to soothe, even temporarily to put out of action, troublesome persons. Sleep treatment of disturbed individuals was rather widely employed 25 years ago (3). In fact, this was so developed that in the early 1920's a good many controversies turned on details of the technic of sleep production.

As experience increased, it became evident that both on induction and on recovery from the deep unconsciousness produced by drugs, deranged patients passed through lucid intervals. Lorenz, in an address given in 1929 (5), showed considerable insight in stating his then current view. It can be put as follows (*2*):

An individual develops a psychosis following normal mental life; this psychosis is at a much lower level of mental activity than the normal. If at this point one precipitates unconsciousness by the use of an anesthetic agent, he can pierce through the stupor and reveal the mechanism. It can be observed upon going into this unconsciousness, as well as upon the return journey from it, that the patient's mental condition approaches the normal; but after his normal mental life has been attained, the various factors responsible for his original psychosis weigh on him, and after a period of some hours he retires to the more primitive level; apparently this seems to him a desirable refuge from normal consciousness.

Much of the work of this period was based upon the assumption that full anesthetization was the important thing. Lindemann (*4*) questioned this, and his points were good. He carried out experiments guided by the assumption that the impressive effects of anesthesia (barbiturate) cannot be sufficiently explained by the unconsciousness produced. He found that small doses of sodium amytal, the agent then in use, even without the production of unconsciousness, produced the same striking changes in the patients as the anesthetic doses. He tried the agent in normal individuals and here, too, found that small doses produced "a feeling of security and well-being, a desire to communicate and to speak about problems of personal matters usually not spoken of to strangers. There was also the feeling of being unable to guard against saying things which one does not want to and an inability to refuse to answer questions even if they refer to very intimate matters. There was a feeling of increased physical and mental abilities . . . ." (This is more than reminiscent of Davy's and Blood's "anaesthetic revelation.") Patients who had been mute for months spoke. Depressed patients gave subjective reasons for their feelings of guilt. "Anxiety and apprehension gave place to mild indifference and a tendency to joke." It is not surprising that the newspapers at once called this agent "truth serum." As the years have passed the important fact has become clear that the patient's inability to hold back extends also to unpleasant emotions. He gives vent to these with relief.

With such chemical tools the analyst was helped to get at this material and to identify himself with the newly revealed past of the patient. The technic was then on the basis where it could be so effectively employed by Grinker and others in the war just ended.

During the war there were now and again startling examples of the use of its powerful machinery to accomplish some trivial thing or to perform some individual cruelty. This curious tale has to do with such a situation and a soldier named Wyatt, who had the misfortune to be caught in an open field by an enemy tank. Through some perverse whim of the tank crew he was not shot, as he easily could have been. Wyatt saw the tank turn and start toward him. As quickly as he could, he threw himself into the nearest slit trench. The tank passed over without harm. His relief was short lived, for it was evident that he was not to escape so easily. The tank reversed and passed again over the trench. Then the horrible truth was clear: he was going to be ground under the tank treads. Each time the tank charged over his narrow refuge its whirling cleats came nearer. He lost consciousness or, more likely, became amnesic. Either the tank crew thought the man adequately disposed of and left or was driven off by a better adversary; Wyatt never knew. At any rate, he survived.

When he was brought into a hospital the whole episode was hidden below the conscious level. He remembered nothing of it and remained a shattered man, driven by

nightmares, unfit for combat or for life outside a hospital. Nothing helped him until he was put half under anesthesia and this blank period probed by a psychiatrist. Finally, he remembered and could talk about it. Without entering the controversy as to the durability of such improvements, it must be agreed that the immediate insight and information obtained and the immediate therapeutic effects are spectacular.

The next example illustrates the use of these agents in a mentally sound but distressed individual.

In most of us is firmly grounded the common belief that wounds are inevitably associated with pain and that the more extensive the wound, the worse the pain. Observation of freshly wounded men in the combat zone (*1*) showed this generalization to be misleading. Even when no morphine had been given for many hours, only one-quarter of the severely wounded men (not in shock) said on direct questioning that they were having enough pain to want anything done about it. Even so, there was a considerable group that came into the forward hospitals writhing and crying out with pain. This is not intended to minimize the fact that wound pain may be agonizing, as it unquestionably was in some cases, but to point out that drugs with anesthetic power—barbiturates in this case—in doses too small to be effective in relieving true pain, serve another and equally dramatic effect. This use of these agents can be illustrated.

It was just after dark on the beachhead, and a heavy rain was sluicing over the wet canvas of the hospital's admitting tent. The wet tent flaps had been yanked back with vigor, and several men tried to enter at once. In addition to the wounded man and the two Italian litter bearers, three others were with difficulty holding the wounded man down. He was a husky fellow of 19. "You fools, let me up. Can't you see I'm lying on my rifle? Get me out of here and off this thing."

The man complained bitterly of the pain in his back. There appeared to be plenty of reason for this: Eight ribs were cut in two and his collapsed lung exposed. Later we found that a sharp rib end had punctured his diaphragm and a kidney. He was so active that no one could examine him adequately, he was blue from inadequate ventilation of the collapsed lung, and he was manic from "pain."

Study of the problems of newly wounded men gave reason to believe that such a man needed something in addition to, or in place of, the usual morphine. Although morphine relieves pain, even in a dangerously large dose it often failed to solve similar problems. Perhaps a barbiturate would relieve this distress.

This soldier had been wounded by a mortar shell five hours before hospital entry and had had no morphine for at least four hours. He was given a small dose of a sedative intravenously, but no morphine. He immediately quieted down and was soon exhaustedly sleeping. He was by no means anesthetized; it was easy to arouse him. He slept, and for the first time it was possible to examine him well. A small dose of a barbiturate had eased the mental distress with the result that his physical agitation let up. It was possible in an hour to get the man into good enough condition to withstand a trying operation, and he got along well.

This case was the forerunner of others in which the great value of small doses of sedatives in relieving the distress of the wounded was established. In some men sedation alone was needed, while in others it was found that one could accomplish with small doses of both a sedative of the barbiturate type and a narcotic (morphine) things that could not be achieved by large doses of either agent alone. Perhaps the wounded soldiers who get "pain" relief from small doses of barbiturates are in the three-quarters of the severely wounded who do not have severe pain, and the hyperactivity, restlessness, and writhing, usually attributed to pain, merely the manifestations of an acute anxiety state, improved by the barbiturates.

Agents that fall into the group of the anesthetics thus have power in addition to their anodyne effects—a power to reveal, to control, and to relieve problems of the mind.

The pain-relieving power of anesthetics was recognized before the emphasis on the laboratory existed in medicine; psychiatry has become aware of the mental effects of these agents only in recent years.

Experimental reproducibility of clinical states is a first requisite in the study of many problems of medicine. With anesthetic agents we seem to have a tool for producing and holding at will, and at little risk, different levels of consciousness—a tool that promises to be of great help in studies of mental phenomena. Thus anesthesia, in presenting a reversible depression, enables the study of the life process itself. The potentialities for future discoveries in this field seem scarcely to have been tapped.

In the biological laboratory, the first-rank problems of anesthesia are as fundamental and as difficult as any in medicine. The anesthetic process is bound up with irritability, one of the fundamental characteristics of living tissue. As Lillie pointed out years ago, the problem of the general nature of anesthesia is inseparable from the wider problem of the nature and conditions of irritability in general. Such truths are as cold and remote as the laboratory from human suffering, but as truths they must be broadly applied to these problems if such agents are not only to have power to relieve pain of body but effective power to resolve distress of the mind.

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The International Congress for Applied Mechanics:

Paris, September 22-29, 1946

Hugh L. Dryden, ***Associate Director,***
National Bureau of Standards, Washington, D. C.

THE SIXTH INTERNATIONAL CONGRESS for Applied Mechanics, held at the Sorbonne, brought together for the first time since the war those scientists interested in theoretical and experimental work on the elastic and plastic properties of materials and structures, fluid mechanics, vibration, sound, friction and lubrication, thermodynamics, combustion, and heat transfer. At the last meeting, held in Cambridge, Massachusetts, in 1938, the American representatives on the international committee were J. S. Ames (since deceased), J. C. Hunsaker, Th. von Kármán, and S. Timoshenko. At the 1946 Congress, Hugh L. Dryden was elected to the international committee as the fourth U. S. representative; and H. U. Sverdrup and R. von Mises, who now reside in the United States, were elected individual members.

The present Congress was organized by a French organizing committee with H. Villat as president and M. Roy as general secretary. The attendance included about 100 Englishmen; 100 Frenchmen; 52 Americans; large delegations from Belgium, Holland, Italy, Switzerland, Roumania, and Czechoslovakia; many from Sweden, Turkey, and Poland; 3 from Russia; and 2 from China. Most of the leading workers in the field were present. It was decided that the next Congress would be held in 1950, but the place was not selected. During the Congress the international committee approved the formation of an International Union of Applied Mechanics, to be affiliated with the International Council of Scientific Unions. A provisional constitution was drawn up, and J. M. Burgers was named as secretary to take the first steps toward the organization of such a union.

The Congress was divided into four sections: I. Structures, Elasticity, Plasticity; II. Hydro- and Aerodynamics, Hydraulics; III. Dynamics of Solids, Vibrations and Sound, Friction and Lubrication; and IV. Thermodynamics, Heat Transfer, Combustion, Theoretical Questions Relating to Nuclear Energy. In addition to regular sessions of the four sections, symposia were arranged on turbulence, seaplanes, plasticity, jet propulsion and turbo-machines, hydraulics, friction and lubrication, supersonic flow, methods of calculation, impact, wing theory, instruments, and measurements. The present report covers chiefly the meetings of Section II.

The Congress was opened on Monday, September 22, at 9:30 A.M., following which Ives Rocard delivered a general lecture on methods of treating problems of nonlinear vibrations, with a great variety of illustrations of practical problems. Section II then convened, papers being presented by F. B. Farquharson, on the aerodynamic stability of suspension bridges; E. Crausse, on an example of resonance due to alternate vortices in an hydraulic installation; and M. Craya and P. Gariel, on the theoretical and experimental aspects of the flow in superposed layers of fluids of different densities.

At the first session of the turbulence symposium, held on Monday afternoon, H. L. Dryden presented a paper entitled "Some Recent Contributions to the Study of Transition and Turbulent Boundary Layers." The paper aroused much interest, since it contained the first public announcement of the work of Schubauer and Skramstad, both of the National Bureau of Standards, in verifying experimentally the Tollmien-Schlichting theory of boundary layer instability and the first complete measurements of the turbulent stress tensor in a separating turbulent boundary layer. G. K. Batchelor, of Cambridge, England, described measurements of certain new aspects of isotropic turbulence. His results appear to clarify the subject of the law of decay of isotropic turbulence. New experimental techniques were described. P. V. Chou presented a theory of turbulent flow along a semi-infinite plate. The other two papers at this session, by A. Fage and A. D. Young, were of a more practical nature, dealing with the effect of surface waviness and roughness on boundary layer transition and the drag of airplane wings.

The session of Section II on Tuesday morning dealt chiefly with the flow of liquids through porous and granular material and with the diffusion of small particles in a turbulent liquid. A general lecture by G. I. Taylor, entitled "Mechanical Tests at Large Velocities of Deformation," described a novel form of testing apparatus in which a lead bullet fired into an anvil extends a tensile specimen at a rate of strain up to 3,000 sec.$^{-1}$. In other experiments rates of strain up to 20,000 sec.$^{-1}$ were obtained by firing steel cylinders 3 inches in diameter with flat ends against armor plate. The ratio of the elastic limit in a dynamic test to that in a static test was found to be as large as 3.0 in mild steel of low yield point, but the ratio decreases to 1.0 when the steel is very hard. Similar results were obtained for duralumin.

The second session of the turbulence symposium was

held on Tuesday afternoon. The first paper, by D. C. MacPhail, described hot-wire experiments on the turbulence between concentric cylinders at speeds up to far above the critical speed. The regular system of vortex rings which forms at the breakdown of laminar motion breaks up into fragments. Although the turbulence is actually three-dimensional, the scale of the turbulence is so much larger in the axial direction than in the radial or circumferential directions that the behavior as to dissipation is roughly two-dimensional. Even at speeds far above the critical, the turbulence spectrum contains a band of preferred frequencies.

The second paper, by P. Guienne, was entitled "Sur la Transition sur une Surface Courbe." The author gave a phenomenological theory of the detailed mechanism of transition on a sphere and of the effect of turbulence. In brief, he considered the case in which laminar separation occurs with a resulting free boundary layer which becomes turbulent and reattaches to the surface. The author uses the suggestion of Von Doenhoff and Abbott that transition occurs in a free boundary layer when the Reynolds number formed from the speed at the separation point and the distance along the free layer from the separation point attains a constant value. The constant value is, however, assumed by the author to depend on the turbulence of the general flow, decreasing as the turbulence increases.

P. Oguey then presented a paper entitled "La Dispersion des Jets d'Eau sous l'Influence de la Turbulence," offering a theory of the breaking up of a jet of water which appeared to ignore the effect of the surrounding air on the outer surface of the jet. The paper was severely criticized by the experimental hydraulic engineers. The word turbulence was used only in a general qualitative sense.

A paper by J. O. Hinze on the mechanism of disintegration of high-speed liquid jets presented the subject from the standpoint of the design of fuel injection systems, *i.e.* jets of small diameter in which surface tension phenomena cannot be neglected and with the usual instability considerations, tearing effect of relative motion of a jet with wavy surface and the air, etc.

H. Rouse described some experiments made in connection with a wartime project for clearing fog from airports, *i.e.* a study of the diffusion of heat from a line source in two-dimensional flow. The experiments dealt with the source located in a boundary wall and were in accord with a simplified theory.

J. Kampe de Feriet's paper, entitled "La Notion de Moyenne dans les Equations du Mouvement Turbulent d'un Fluide," was a discussion of the necessary and sufficient conditions imposed on the turbulent fluctuations to insure that the various mean values occurring in the Reynolds equations of turbulent motion should obey the rules of mathematical logic. Mathematically expressed, the spectra of the turbulent fluctuations must contain extended regions of zero intensity; physically expressed, there must be a definite range of space and time intervals such that the average values over these intervals are independent of the size of the interval. The paper aroused much discussion. It seems clear that there may be some turbulent motions for which Reynolds equations are not very useful, because the mean values are continuously changing functions of the interval over which the averages are taken, but there are many other cases where the assumptions are valid.

The final paper, by A. Favre, described apparatus for the measurement of time correlations in turbulent motion. The output of any convenient apparatus giving an electrical current proportional to the instantaneous value of the velocity is recorded on magnetic wire or tape. Two pickups can be spaced at any desired distance to reproduce the values of velocity at two times which differ by a constant amount corresponding to the distance between the pickups and the speed of the wire or tape. After amplifications (as modulations of a carrier frequency later rectified) the outputs are applied to the vertical and horizontal plates of a cathode-ray tube. The correlation is determined from the pattern on the screen.

At the Wednesday morning session of Section II the following papers were presented: "Sur l'Impossibilité pour un Fluide Visqueux Homogene ou Heterogene d'un Mouvement à la Poinsot," by M. Berker; "Hydrodynamique Plane des Liquides Visqueux," by G. C. Moisil; and "Le Mouvement Rotationnel d'un Fluide," by I. Carstoin. H. A. Einstein gave a good general review and some speculations on the transport of sediment by streams of water. Two papers on the stability of laminar flow provoked much discussion. Th. von Kármán presented C. C. Lin's paper on the stability of two-dimensional parallel flow which has been available for some time in this country. D. Meksyn, who presented a paper on the stability of viscous motion between parallel planes, was sharply critical of the work of Tollmien and others. A full report of his work is to be published in the *Proceedings* of the London Mathematical Society. He seemed to have made some improvement in the accuracy of the mathematical computation of the stability limit but insisted that the other workers, including Lin, were wrong in spite of the good experimental confirmation of their work by the experiments of Schubauer and Skramstad at the National Bureau of Standards. The meeting of Section II was occupied largely with the work of S. Bergman, H. Poritsky, and H. Kraft on compressible flow problems. Their papers in this field are available in this country. R. Smelt presented a paper on the longitudinal stability and trim changes of an aircraft through the speed of sound, in which some of the earlier wartime work was described.

On Thursday morning the first session of the symposium on supersonic flow was held. W. F. Cope and G.

Hankins described in two papers some theoretical and perimental work on the Reynolds number effect on ojectiles at supersonic speeds carried out at the tional Physical Laboratory. W. D. Hayes presented theoretical treatment of linearized conical supersonic w. J. Ackeret described very briefly the work in prog- at the Zürich Aerodynamic Institute on shock waves the mechanism of compressibility drag. John Stack, the National Advisory Committee for Aeronautics, sented a paper on the flow around a sharp leading e of an airfoil at supersonic speeds. Pruden and lensi showed a large number of pictures of shock- ve patterns in high-speed flow.

At the concluding session of this symposium, held in afternoon, Ackeret showed motion pictures of the velopment and changing character of shock-wave tterns with increasing Mach number and increasing ynolds number for laminar and turbulent boundary yers and of the unsteady motion when an airfoil lattice driven above the blocking speed using the surface wave alogy of compressible flow. Papers which created much erest were those of Th. von Kármán on some in- stigations of transonic and supersonic flow and of W. Maccoll on the investigation of compressible flow sonic speeds.

On Friday afternoon, at a third session of the tur- lencc symposium, there was some further discussion Dryden's paper. Batchelor then presented a brief re- rt on some recent theories regarding the correlation efficient in isotropic turbulence at high Reynolds mbers. Three scientists, Kolmogoroff in the U. S. S. R., nsager in the United States, and C. F. Weizsäcker in llaboration with W. Heisenberg in Germany, obtained e same result (that the correlation between parallel locity fluctuations at two points distant r apart proaches the form $1 - Ar^{2/3}$ at high Reynolds number, ovided r is small compared with the scale of the rbulence) by theories which have some elements in mmon but which vary in mathematical formulation. N. Frenkiel presented his measurements of correlation d other aspects of turbulent flow conducted under the idance of Kampe de Feriet. H. L. Dryden presented a per for H. Liepmann, of the California Institute of Technology, on measurements of turbulent shear flow.

The closing session of the symposium on supersonic flow was held on Saturday morning. A. C. Charters, Jr., described the spark photography range of Aberdeen Proving Ground. Riabouchinski reviewed his theoretical and experimental work on compressible flow. Teofilato discussed the well-known analogy between compressible flow of a gas and a current field in water. Bartels and Laporte discussed a linearized theory of the supersonic flow over conical bodies at an angle of yaw. Frank Malina discussed the problem of escape from the earth by means of a rocket, giving the usual one-stage and multi-stage simplified calculations and concluding that the technical accomplishment was nearly within sight.

The Congress closed with an official session at noon, at which representatives from several countries formally expressed appreciation for the work of the French organizing committee. The principal social events of the Congress were receptions by the organizing committee, by the city of Paris, and by the British ambassador, and a visit to the palace of Versailles with an informal dinner in the town.

There were, of course, many important papers presented at other sessions. In particular, Section II had sessions on hydraulics, hydrodynamics of ships, jet propulsion, theory of flow around wing sections, and general hydraulics which occurred concurrently with the sessions described.

It is difficult to pick out individual contributions as outstanding. The Congress included many papers describing war work, now released, which had been done in connection with aeronautics, ballistics, and structural design. There were also many contributions which represented work carried out in occupied countries in secrecy and under great difficulty. The contributions from America and Great Britain were of a high standard and represented a sharing of fundamental scientific knowledge with no threat to military security. The contributions from other nations were, on the average, perhaps not as far advanced, but there were important exceptions, such as the work of Ackeret and his colleagues on shock waves, of Crocco on supersonic diffusers, and of Koiter on buckling of plates.

Scanning Science—

The annual report of the Provost of the University of Pennsylvania, with the appended documents, makes a volume extending to 248 pages. It covers, however, a period of more than two years, from June 9, 1894, when Mr. Harrison assumed the duties of acting Provost, to September 1, 1896. This will probably always be regarded as one of the most important periods in the history of the University. . . . the chief gains [in the scientific departments] have been the appointments of Professor C. A. Doolittle, in astronomy; Professor E. G. Conklin, in comparative embryology, and Professor A. C. Abbott, in hygiene.

—February 5, 1897

The Organization of Arthropod Cuticle:

A Modified Interpretation

A. Glenn Richard

Division of Entomology and Economic Zoology, University of Minnes

IT IS GENERALLY CONSIDERED THAT THE exoskeleton of insects, crustacea, arachnids, and other arthropods is composed primarily of a polysaccharide called chitin, with or without the additional statement that other substances such as lime, pigments, proteins, and an external waxy layer are present. In fact, textbooks usually characterize these cuticles simply as "a chitinous exoskeleton." A few papers and the well-known textbook by V. B. Wigglesworth are noncommittal. A reanalysis of the situation, including new data, has led the writer to the view that the phrase "chitinous cuticle" is misleading if not actually fallacious. A more detailed analysis is being published elsewhere, but because of the desire to present the shift in viewpoint to the wider audience of general biologists, a digest of the facts is presented here.

The cuticle of arthropods is the secreted ("nonliving") layer covering the exterior surface of the body, the cuticular appendages such as setae, scales, and sense organs, and also the corresponding surfaces of certain invaginated parts such as the fore and hind guts, the genital ducts, apodemes, and tracheae—all of which show the same type of structure and organization, though there are obvious variations in thickness, hardness, and color.

The evidence for calling these cuticles "chitinous" seems based on the remarkable chemical stability and insolubility of chitin, the retention of recognizable structure after removal of other components, the presumed general occurrence of chitin, and perhaps the fact that chitin is the best known chemically. Chemical stability, insolubility, and information on structure can be summarily dismissed as irrelevant to the question of what are the basic components of arthropod cuticle. The retention of structure after purification is not valid evidence, both because chitin is insoluble in the agents used for purification and because newer methods show that only the grosser structure is retained. The idea that chitin is of general occurrence has numerous exceptions (which are usually ignored!). Insect tracheae and butterfly scales, and even different tracheae or scales of a single individual, may be found either with or without this substance. Also, the epicuticle (outermost layer of the cuticle) is said always to lack chitin. Even membranes which give positive tests for chitin may contain extremely low percentages of this substance. Chitin is recorded as usually accounting for 20–40 per cent of the dry weight of the cuticle, but although the amount m in a few cases rise to as high as 60 per cent, it may al drop to as low as 1–2 per cent. With such a range quantitative determinations already available, it see likely that we must eventually say that the chitin conte of different cuticles varies from 0–60 per cent.

It seems to the writer difficult to view the arthrop cuticle as primarily chitinous when these highly speci structures retain similar structure, even in electr micrographs, whether chitin is present, nearly abse or completely absent. In view of the above facts t present writer feels forced to conclude that the evide in favor of calling the arthropod cuticle chitinous is n convincing, and that either there is no chemical co stancy to the basic pattern of arthropod cuticles or t constancy must be due to something other than chit which is always present in reasonable percentage.

Since it has been pointed out above that insolubili is not a valid reason for calling arthropod cuticle "chiti ous," it follows that the basic framework does not ha to possess this quality. In re-examining the componen in this light, one is impressed with the fact that t cuticular proteins fit all the requirements for being t basic component of the cuticular membranes of arthr pods. There are no known examples of cuticular me branes which lack these proteins. Irrespective of t percentage of chitin, the percentage of protein is alwa high. While little is known about the composition of the proteins (there is only one preliminary paper), a su ficiency of data attests their general occurrence. course, it is not possible to say that cuticular membran lacking proteins will never be found; if such are foun we will have to conclude that there is no chemic constancy to the cuticular framework. At present it seem more reasonable to assume both that these proteins a always present, necessarily plasticized, and that the form the basic molecular framework which is various modified by other substances (usually including chiti to produce the various recorded subtypes.

Biologists will recognize that the above argument based on the type of thought used in comparati anatomy. The concepts affected involve mostly o orientation toward further analysis of the molecul architecture of cuticle and our interpretation of t development of these membranes. The analysis arthropod cuticle is still in such a state of infancy tha it seems unwise to hazard any guesses as to the eventu

cts of such a change of concept for membrane proper- and permeability. The obvious effect on anatomical nking is to abolish the concept of the cuticle being a tinous sheet with a fundamentally different layer on outside (epicuticle). This concept is replaced by that a continuous protein layer, usually modified by the dition of waxes on the outer surface and chitin and, often, other substances in the inner region.

Quite likely, an extended polemic about a single "basic" component would be futile. The arthropod cuticle is obviously a highly complex organization. All that can safely be said at present is that the known manifestations are consistent with the view that arthropod cuticles are variously modified protein membranes and are not consistent with the view that they are basically chitinous.

NEWS
and Notes

Two bills providing for a National ience Foundation were introduced the Senate on Friday, February 7. e first bill, now numbered S. 525, s introduced by Senator Elbert D. omas of Utah and is identical with 1850, which passed the Senate in e 79th Congress, but which died in House Committee.

The new bill introduced by Senator H. exander Smith of New Jersey is a com- mise measure, which Mr. Smith be- es avoids the controversial features the Kilgore-Magnuson bill (S.1850) of last session and S.525 of this. Senator ith, who is a Republican, said that he s directed by Robert A. Taft of Ohio, jority leader of the Senate, to prepare a artisan bill in an effort to get a Na- nal Science Foundation established in s session. Accordingly, Senators War- n G. Magnuson and J. W. Fulbright, o are Democrats, and Republicans Guy rdon, Chapman Revercomb, and Lev- tt Saltonstall joined with Senator ith in introducing the new bill.

Both bills were referred immediately to e Senate Committee on Labor and Pub- Welfare, of which Senator Taft is the airman.

The new Smith Bill provides for the eation of a National Science Foundation mposed of 48 "outstanding men and omen who are recognized leaders in the lds of the fundamental sciences, medical ience, engineering, education, or public fairs" to be appointed by the President. This body is authorized to develop and encourage scientific research in the interest of national welfare and defense, including the award of scholarships and fellowships and global interchange of scientific information.

The 48 members of the National Science Foundation would delegate broad powers to an executive committee of 9 members, who would select the director and deputy director of the Foundation. These positions would be full-time jobs at $15,000 and $12,000 annually.

The bill provides for the immediate establishment of 5 divisions: medical research, physical sciences, biological sciences, national defense, and scientific personnel and education. The inclusion of the social sciences is left to the judgment of the Foundation.

The new bill does not estimate the annual cost of the program, but authorizes such sums as may be necessary to carry out the provisions.

On Friday, February 7, Senator Smith said that the number of persons suggested in the bill, 48, bears no relation to the number of states and may prove to be unwieldy. Presumably, a smaller number, perhaps 24, might ultimately be decided upon. Senator Smith also said that in his opinion the Foundation would have jurisdiction over atomic research of a nonmilitary nature. The new bill does provide for the distribution of funds by states. This was one of the controversial features of the earlier bills introduced into the last session, and, according to Senator Smith, any attempt to introduce this feature into S. 526 will not be acceptable to the sponsors of the measure. He said: "The sponsors of this legislation are aware of the fact that they are pioneering in a new field. They are convinced that, if this experiment is to be a success, the greatest possible latitude must be given to the scientific experts throughout the United States to determine what research in basic science is entitled to and is in need of Federal support, and who are the most promising younger members of the profession who are entitled to scholarships or graduate fellowships to complete their education." He went on to say ". . . that the development of the Foundation should be by the trial-and-error method with amendments to the basic act from time to time as the experiment proves necessary."

As has previously been announced in *Science*, the AAAS is planning an Inter-Society conference on the National Science Foundation on February 23, at which time it is expected that the new bills will be compared and analyzed.

Leaders in the Congress who have been concerned with a National Science Foundation have been invited to spend Sunday evening with more than a hundred delegates to the Inter-Society conference. In next week's issue of *Science* the complete text of the new S. 526 will be published.

Maj. Gen. H. S. Aurand, director of Research and Development, War Department, spoke before 1,500 physicists at the joint annual meeting of the American Physical Society and American Association of Physics Teachers at Columbia University on January 30.

During World War II, he said:

> . . . The military man's respect for the scientist was greatly increased. Those of us who had the opportunity to work with scientists during World War II were amazed at your vision, your intense devotion to your work, and your calm assurance of purpose. Time after time, when the chips were down, the scientists came through with the answers.
>
> Here at home, in your laboratories, you

quietly and without fanfare provided us with the marvelous defensive and offensive weapons which spelled the difference between success and defeat. That the War Department could fail to recognize the necessity for a greatly increased Research and Development Program after World War II is unthinkable.

The absolute necessity for the closest association between the scientist and the military was made obvious; yet at the very time that this occurred, the agencies with which the military had been dealing —the Office of Scientific Research and Development and the National Defense Research Committee—were winding up their work.

During the past 7 months, since I became Director of Research and Development, neither of these agencies has taken on any new problems. On the contrary, many of the things which they had in progress were taken over by the War Department, in order that these promising projects would not die.

The War Department fully realizes that if it is to stay ahead of its competitors, it must maintain close association with scientists. As I have already stated, the basic knowledge necessary to stay ahead of our competitors must come from science. We are greatly in need of an official agency of science with which to maintain this contact. You can readily see that the War Department is highly desirous of having this Congress establish a National Science Foundation of some sort at as early a date as possible.

The performance of this task of collaboration between science and the military is not the only reason why the War Department wants the National Science Foundation. There should be a clearing house for Federal research contracts, in order that the War Department, which is just one of many Federal agencies with a Research and Development Program, may know whether work is already being undertaken elsewhere in a field which it desires to explore. It needs to know the best place to go for its pure research work, as well as the best qualified people to do the job it has in mind. And finally, there has to be some sort of mobilization plan for science, not only in the event of an emergency, but to carry on the necessary research work in peacetime. The War Department is not the agency to prepare such a plan; yet in the absence of such agencies, the Research and Development Division has felt compelled to go ahead with planning in this field in cooperation with the National Research Council and other civilian agencies that are concerned with the plans of scientific manpower. A National Science Foundation could do all of these things with propriety. . . .

About People

Lloyd W. Law has recently been appointed director of scientific administration, Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine.

F. H. McCutcheon, formerly, professor of zoology, North Carolina State College, is now professor and head, Department of Physiology and Pharmacology, School of Veterinary Medicine, University of Pennsylvania, Philadelphia.

H. S. Armstrong, assistant professor of geology, McMaster University, Hamilton, Canada, was named assistant dean of arts and sciences September 1, 1946.

R. H. Peckham, Cdr., H(S), USNR, has returned as associate professor of physiological optics in the Medical School, Temple University.

Rupert Wildt, Yale University, has been appointed visiting professor of astronomy at the University of Basle for the academic semester, March–July 1947. In February he will give a series of lectures at the Institut d'Astrophysique, Paris.

L. Kermit Herndon has been promoted from associate professor to professor of chemical engineering at Ohio State University. Frederick J. Salter, at the same time, was made associate professor of agronomy.

Fellowships

The University of Michigan, in cooperation with the city of Flint, will grant six $1,000 fellowships to graduate students in the social sciences in 1947–48. Grants will be made as part of a long-range Social Science Research Project on social, economic, and political problems of the Flint metropolitan area.

Two operating units have been organized to promote the project. On the University campus focus is the Metropolitan Community Seminar, attended by faculty representatives of participating departments, fellowship recipients, and resident director of the project in Flint. Participating departments are economi geography, political science, public a ministration, sociology, and architect and design. Faculty members of the Se inar are Edgar M. Hoover, Robert Hall, Arthur W. Bromage, John A. P kins, Amos H. Hawley, chairman, a John W. Hyde, respectively. The semi enables interchange of ideas, techniqu and knowledge among the various fie of training.

The office in Flint is comprised a full-time resident director, Vict Roterus; clerical and stenographic ass tance; and the Flint Advisory Boa whose members represent a wide range local interests. Functions of the Flint u include guidance of local public relatio consultation on research, facilitation field research, and advice on local pu lication and distribution of research r ports.

Financing of the project is equal divided between the University a groups in Flint.

Administration of the project is in t University's Institute for Human Adjus ments, under direction of Clark Tibbitt

Inquiries and applications for fello ships for 1947–48 should be sent to Ral A. Sawyer, dean, Horace A. Rackha School of Graduate Studies, University Michigan, Ann Arbor, Michigan.

Colleges and Universities

The California Institute of Tech nology, Pasadena, California, has a pointed Max Delbrück, associate prof sor of physics, Vanderbilt University, professor of biology to begin July 1, 19 N. H. Horowitz, senior fellow in resear California Institute of Technology, h been promoted to associate professor biology.

The Ohio State University has be awarded $25,000 by Swift & Compan Chicago, to finance a five-year resear project on poultry breeding under George Jaap, professor of poultry hu bandry. Dr. Jaap, editor of *Poult Science,* and former Oklahoma A. & M College staff member, joined Ohio Sta this year.

Industrial Laboratories

Esso Laboratories, Standard O Company, New Jersey, have develop a new-type synthetic resin from petr leum which can be applied successfully iron, brass, bronze, aluminum, and high

polished metal, in addition to wood and steel. It also promises good results as a base for textiles, footwear, and rubber adhesive.

The substance, called A-resin, was developed in cooperation with technicians of the paint and varnish industry, the current issue of *The Lamp*, Standard Oil publication, reports. When the work was started three years ago, no satisfactory process had been developed to make quality synthetic resins from crude oil.

As a baked priming coat on automobiles it is hard, durable, light-fast, and chemically resistant. Coating for a can only 2/10,000 inch thick remains unbroken when metal sheets are stamped and punched, withstands pasteurization treatment of 20 minutes, and is unaffected by high acidity. It is a short-oil-length resin, which means economy of drying oil, *The Lamp* said.

Heat from atomic energy piles may be used as heat in chemical or metallurgical industries where primary heat is required, C. G. Suits, vice-president and director of the research laboratory, General Electric Company, stated in a science forum at Schenectady recently. The atomic power plant will manufacture important new by-products such as fissionable material and a variety of radioactive chemical compounds which, he pointed out, will make the plant more analogous to a chemical manufacturing plant than an electric generating station.

General Electric now has under construction at Schenectady a new $8,000,000 General Electric research laboratory, and a $20,000,000 nuclear research laboratory, to be named Knolls Atomic Power Laboratory, fourth in the network of national laboratories for the Manhattan Project. The Company also recently took over the Hanford Engineer Works, Richland, Washington.

Meetings

The American Geophysical Union will hold its 28th annual meeting in Washington, D. C., April 28–30. Headquarters will be in the National Museum.

"**Federal Control of Drugs and Cosmetics**" will be the subject of the February 25 meeting of the Symposium on Medicolegal Problems, Chicago Bar Association, Chicago. Anton J. Carlson, professor emeritus of physiology, University of Chicago, and former president of AAAS, will preside. The medical presentation will be made by Morris Fishbein, editor, *Journal of the American Medical Association*, and the legal presentation by Alvin M. Loverud, counsel, Food and Drug Division, Federal Security Agency, Washington, D. C.

The symposium, under cosponsorship of the Institute of Medicine of Chicago, Chicago Medical Society, and Chicago Bar Association, runs from February 4 through March 4.

The American Association of Anatomists will hold its annual meeting in Montreal, Canada, April 3–5, at the invitation of McGill University. Headquarters will be the Mount Royal Hotel.

The American Association of Cereal Chemists will hold its 32nd annual meeting at the Hotel President, Kansas City, Missouri, May 19–23.

William A. Haley and A. J. King, Fisher Flouring Mills Company, are program chairman and editor, respectively. Sessions and their leaders are: sanitation and contamination control, Gaston Dalby, Ward Baking Company; human and animal nutrition, Frank Gunderson, Pillsbury Mills, Inc.; enzymes, Eric Kneen, Kurth Malting Company; baking chemistry and technology, C. J. Patterson, president, C. J. Patterson Company; agronomy and milling technology, John A. Shellenberger, Kansas State College; and general session, Hugh K. Parker, Wallace and Tiernan Company.

Papers for presentation at the convention with abstracts of 200 words should be sent to the Program Committee. Exhibitors wanting display space should communicate with Fay Buck, Kansas Flour Mills Corporation, North Kansas City 16, Missouri.

The Optical Society of America will hold its winter meeting at the Hotel Pennsylvania, New York City, February20–22. A total of 55 papers will be presented. The American Institute of Physics will conduct a placement register in connection with the meeting, registration forms for which may be obtained from the Institute Office, 57 East 55th Street, New York 22, New York.

The American Mathematical Society will hold its 423rd meeting at Columbia University on February 22. There will be 26 papers, and at the afternoon session N. H. McCoy, Smith College, will deliver an address entitled "Subdirect Sums of Rings," at the invitation of the Society.

Elections

The Eastern Pennsylvania chapter of the Society of American Bacteriologists elected Harry E. Morton, University of Pennsylvania, president, and Amedeo Bondi, Jr., Temple University, secretary-treasurer, for 1947.

The Nebraska section of the American Chemical Society has elected the following officers for 1947: Carl E. Georgi, University of Nebraska, president; D. E. Fox, Kearney, Nebraska, State Teachers College, vice-president; Raymond Borchers, Nebraska Agricultural Experiment Station, secretary-treasurer; and Walter Militzer, University of Nebraska, councilor.

The Society for the Study of Evolution, at its first annual meeting in Boston January 28–31, elected the following officers: J. T. Patterson, president; L. R. Dice, G. L. Stebbins, and A. S. Romer, vice-presidents; S. A. Cain, Cranbrook Institute of Science, Bloomfield Hills, Michigan, secretary; K. P. Schmidt, Chicago Natural History Museum, treasurer; and E. Mayr, American Museum of Natural History, New York, editor of the quarterly research journal, *Evolution*, which will appear for the first time in May. Orders for subscriptions to the journal may be sent to the treasurer.

The American Ethnological Society has elected for 1947, E. Adamson Hoebel, president; Sherwood Washburn and Margaret Mead, vice-presidents; Esther S. Goldfrank, secretary-treasurer; Rene d'Harnoncourt, Julian H. Steward, and Carl Withers, directors; and Marian W. Smith, editor.

The John and Mary R. Markle Foundation has announced election of Dorothy Rowden, former member of the Columbia Broadcasting System Education Division, as secretary of the Foundation beginning February 1. Miss Rowden was assistant to the director of the American Association for Adult Education and research associate of the Institute of Adult Education, Teachers College, Columbia University. For two years she was editor of the *American Library Association Bulletin* and in charge of public relations for the Association. She succeeds Florence E. Quick, who retires as secretary but will

continue as part-time administrative assistant.

The Markle Foundation is engaged in support of medical research and has expended over $4,000,000 for this purpose through medical colleges and other medical institutions since 1936.

The first *Catalog of auxiliary publications in microfilms and photoprints*, listing about 2,000 documents, has been published by the American Documentation Institute and may be obtained free by writing the Institute, 1719 N Street, N. W., Washington 6, D. C.

The catalog lists documents deposited with the Institute under its auxiliary publication program, established in 1937 to enable scientists and scholars to publish important papers too long for technical journals. Any of the documents listed may be obtained on 35–mm. microfilm or in photoprints 6 x 8 inches at rates listed in the catalog. Many translations of foreign-language papers are included. Also available in microfilm are sets of scientific journals for use of libraries unable to get runs of the issues missed. Back volumes of *Science* are available in this manner.

Officers of the American Documentation Institute are Watson Davis, president; Keyes D. Metcalf, vice-president; Steuart H. Britt, treasurer; and Helen M. Davis, secretary.

A list of 864 standards approved for national use of industry by the American Standards Association was published recently by P. G. Agnew, vice-president of the Association. The revised list, which includes many of those developed under war procedure and now approved for peacetime use, will be available to interested trade, technical, and governmental bodies and individuals without charge.

The standards listed include definitions of technical terms, specifications for metals and other materials, methods of work, and methods of test for finished products. They also include standards dealing with public and industrial safety, industrial medicine, and a wide variety of consumer goods.

These standards represent agreement on the part of maker, seller, user and regulatory groups as to the best possible practice at the time of approval and are revised periodically to keep up with mechanical invention, developments of power, and new uses for materials.

The list represents the cumulative efforts of about 3,000 men, representing 660 organizations working on the development of standards.

The New York Zoological Society recently received a legacy of approximately $2,500,000, largest single gift in its history, Fairfield Osborn, president, announced at the 51st annual meeting in New York January 21. He also announced other gifts totaling $282,000.

The legacy is a share in a trust fund established by the will of Mrs. Frederick Ferris Thompson, of which former New York superintendent of banks, Clark Williams, was life beneficiary.

Future needs of the Zoological Society total $5,000,000, Mr. Osborn said. Of this, $1,500,000 will be devoted to conservation, education, and research; $2,250,000 will be used for the new aquarium which the Society and New York City are planning; and $1,250,000 will go toward an extensive modernization program of the Zoological Park.

In his report to members Mr. Osborn said the Society had completed its fifth successive year with a balanced budget, all expenses being met by income from capital funds and members' dues. Total membership has more than doubled since a membership campaign was undertaken in the spring of 1945.

Robert M. Hutchins, chancellor, University of Chicago, addressed the meeting on "What Man Has Made of His World."

Recent Deaths

William A. Moody, 86, Wing professor emeritus of mathematics, Bowdoin College, Brunswick, Maine, died in Brunswick, February 2. He had served on the faculty from 1884 until 1926.

Francis William Maclennan, 70, vice-president and consulting engineer of the Miami, Arizona, Copper Company, died in Los Angeles, January 28.

George W. Mixter, 70, consulting engineer, chief of the production division of American aviation in World War I, died in New York January 29. He was author of *Primer of navigation*, basis for teaching navigation to more than 100,000 men in the recent war.

Paul Langevin, 74, director of the École de Physique et Chimie Industrielle, Paris, died December 30.

H. St. J. L. Winterbotham, 68, recent general secretary of the International Geodetic and Geophysical Union, died in England December 10.

F. M. Rowe, 55, professor of color chemistry and dyeing, University of Leeds, England, died December 8.

Samuel O. Mast, 75, emeritus professor of zoology, The Johns Hopkins University, died February 3 in Baltimore.

Morgan Hebard, 59, research fellow and former curator of insects, Academy of Natural Sciences of Philadelphia, died December 28. In 1945 Mr. Hebard presented his collection of Orthoptera, containing some 250,000 specimens, to the Academy, with which he had been affiliated for over four decades.

Charles Francis Doney, 39, assistant horticulturist, Brooklyn Botanic Garden, died in Buffalo, New York, January 6. He had been with the Botanic Garden since 1931.

NRC News

A Committee on Classification of Scientific Personnel, with responsibility of advising the Civil Service Commission on basic standards of classification of scientific employees, has been established with the following members: Elmer Higgins, chief, Division of Fishery Biology, Department of Interior, chairman; Edward U. Condon, director, National Bureau of Standards; and H. C. McPhee, assistant chief, Bureau of Animal Industry, Department of Agriculture.

The Committee is an outgrowth of the Advisory Committee on Scientific Personnel, established by the Civil Service Commission under chairmanship of M. H. Trytten, director of the Office of Scientific Personnel (*Science*, April 12, 1946). To assist in its work in special fields the new Committee has set up a panel of experts in each of a number of areas: A. V. Carlin, Weather Bureau, meteorology; G. C. Clemence, Naval Observatory, astronomy; Francis M. Defandorf, Bureau of Standards, physics; Kenneth E. Lohman, Geological Survey, geology; Charles E. Kellogg, Bureau of Plant Industry, soil science; Edgar R. Smith, Bureau of Standards, chemistry; and Charles Whitten, Coast and Geodetic Survey, mathematics.

The Civil Service Commission recognizes that classification of scientific employees is a problem presenting fundamental differences from classification of

administrative employees generally, and believes qualified scientists can contribute greatly to development of a simpler and more satisfactory principle and method of classifying this type of employee.

Make Plans for—

American Association of Junior Colleges, 27th annual meeting, February 19–22, Hotel Jefferson, St. Louis, Missouri.

Alpha Epsilon Delta, five-state conference on premedical education, February 21, 22, University of Louisville, Louisville, Kentucky.

Eastern Association of Electroencephalographers, February 21–23, Montrea Neurological Institute, Montreal, Canada.

American Society of Mechanical Engineers, spring meeting, March 2–5, Tulsa, Oklahoma.

Western Metal Congress and Exposition, fifth, March 22–27, Civic Auditoriums, Oakland, California.

Society of American Bacteriologists, annual meeting, May 12–16, Bellevue-Stratford Hotel, Philadelphia, Pennsylvania.

American Oil Chemists' Society, 38th annual meeting, May 20–22, New Orleans, Louisiana.

American Society of Mechanical Engineers, oil and gas power 19th national conference, May 21–24, Cleveland, Ohio.

American Society of Mechanical Engineers, aviation meeting, May 26–29, Los Angeles, California.

American Society of Mechanical Engineers, wood industries national conference, June 12–13, Madison, Wisconsin.

American Society of Mechanical Engineers, semiannual meeting, June 16–19, Chicago, Illinois.

American Society for Engineering Education, 55th annual meeting, June 18–21, University of Minnesota, Minneapolis.

Chemical Society, London, centenary meeting, July 15–17, London, England.

International Congress of Pure and Applied Chemistry, 11th annual, July 17–24, London, England.

International Physiological Congress, 17th annual, July 21–25, Oxford, England.

COMMENTS
by Readers

E. V. Cowdry presented an excellent case for more adequate support of cancer research by the Federal Government ("Financing Cancer Research," *Science*, January 17). However, the wisdom of his contention that this support should come through the enactment into law of the Neely-Pepper Bill (S. 93), which calls for a $100,000,000 Federal appropriation for cancer research, may be questioned. The passage of S. 93 by Congress might well pave the way for similar bills seeking support for research on heart disease, arthritis, hypertension, arteriosclerosis, the common cold, and a number of other diseases which, because of the morbidity, mortality, or economic loss entailed, are at least as important as cancer to the people of the United States. If appropriations for research on specific diseases are proper, would not Federal laws financing various research programs in biology, the physical sciences, and the social sciences be logical?

As one actively interested in the conquest of cancer, I favor more adequate government support of cancer research but only in proportion to the research needs of other fields of medicine and science. This is in keeping with the democratic principle of promoting the welfare of all elements of our citizenry. Those who wish to contribute to research in particular fields of medicine such as cancer, heart disease, arthritis, hypertension, tuberculosis, and infantile paralysis may do so individually through the semipublic organizations already established to advance education, service, and research in relation to these diseases.

Should not the problem of more adequate Federal support for research in cancer and other fields of science be solved through the establishment of a National Science Foundation such as that envisioned by the compromise Kilgore-Magnuson Bill (S. 1850) considered by the last Congress? The administrative officers of the Foundation, in consultation with the Advisory Board and Committees of the Foundation, would determine the monies to be budgeted for research in the various fields of science, including cancer. Presumably, the Foundation would be more competent to decide the relative merits and potential productiveness of such research programs from year to year than legislative pressure groups, no matter how sincerely motivated.

Accordingly, I urge that all American scientists unite and work unselfishly for the establishment by the present Congress of a National Science Foundation capable of effecting maximum utilization of the scientific talents of the Nation in all fields. (GEORGE E. WAKERLIN, *Department of Physiology, University of Illinois College of Medicine, Chicago.*)

José Oliver-González' article, "The Possible Role of the Guppy, *Lebistes reticulatus*, on the Biological Control of *Schistosomiasis mansoni*" (*Science*, December 20, 1946, p. 605), confirms certain observations made here in our aquaria, where we have also found that guppies feed not only upon mollusk eggs and their embryos, but persist in attacking the tentacles of the mollusks until these are eventually nipped off. The tentacle of the snails is said to serve as a preferred part for the attack of the cercaria.

Some years ago I was asked by Puerto Rican scientists for methods to control the intermediate molluscan hosts of the liver fluke. I then suggested the introduction of domestic ducks in the areas invaded, since these birds readily feed upon mollusks and should be a help in reducing or eliminating them in infected areas. I wish here to offer the same suggestion for the control of *Australorbis*. The ducks would serve not only as a help in eliminating the malady but would furnish, in addition, a desirable food element for the crowded population of the island. (PAUL BARTSCH, *associate, Division of Mollusks, Smithsonian Institution, Washington, D. C.*)

TECHNICAL PAPERS

Synthetic Caffeine

CHARLES C. SCOTT, E. BROWN ROBBINS, and K. K. CHEN

Lilly Research Laboratories, Eli Lilly and Company, Indianapolis, Indiana

The identity of a synthetic compound with a natural product is usually made by the determination of physical constants such as the melting point, mixed melting point, and elementary analysis. However, with the many pharmacologically active substances, such as hormones and vitamins, a biological assay has been employed to supplement chemical identification. This appears important and necessary, because sometimes the physical constants do not completely establish the absolute purity of the product. Recently, for example, there was encountered in this laboratory a sample of synthetic pyridoxine which answered the specifications of *New and nonofficial remedies* (*4*), but which proved to be much more toxic than the standard.

Synthesis of caffeine and theobromine was initiated by Fischer and his co-workers (*1*), and newer methods of synthesis, partial or complete, have been achieved by other investigators (*5*). Previously, we studied the synthetic alkyl derivatives of theobromine (*3*). As an extension of the above work, it occurred to us that pharmacological proof of identity of totally synthetic caffeine and commercial caffeine made from a natural intermediate was desirable. The latter is usually prepared by methylation of theobromine. Samples of both were generously supplied by L. P. Kyrides, research director of the Monsanto Chemical Company, St. Louis, Missouri. The melting point of commercial caffeine ranged between 234.5 and 237° C.; that of synthetic caffeine, between 234.5 and 237.5° C.; and the mixed melting point, between 235 and 237° C.

Two types of experiments were carried out—one, the measurement of the stimulation of the central nervous system in rats; the other, the comparison of toxicity in mice by intravenous injection. The central stimulating action was evaluated in spring-suspended cages according to the method of Schulte and co-workers (*2*). Ten rats, weighing between 230 and 280 grams, were employed. A fixed dose of 20 mg./kg. of each drug in 0.5 per cent solution was injected subcutaneously. The observation period was exactly 4 hours, counting from the time of injection. Five animals received synthetic caffeine, and the other 5, the commercial. On the following day a cross-over test was made—those receiving the synthetic caffeine the previous day received the commercial, and vice versa.

For the toxicity study, mice weighing from 14.6 to 19.3 grams were used. The concentration of the solution was the same as for rats (0.5 per cent). Both samples were run on the same day.

The results are unequivocal. The average number of revolutions recorded from the cages by the 10 rats for commercial caffeine was 34.8; for synthetic caffeine, 34.1; and that of the control test (without medication), 5.1. The median lethal dose (LD_{50}) by intravenous injection of commercial caffeine in 30 mice was found to be 79.36 ± 6.94 mg./kg. The LD_{50} of synthetic caffeine in 30 other mice was determined to be 75.51 ± 5.39 mg./kg. There is no significant difference between the two figures statistically.

Pharmacological results indicate, therefore, that commercial caffeine and synthetic caffeine have the same degree of central stimulation and toxicity.

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Visibility of the Deer Fly in Flight[1]

ELEK LUDVIGH

Howe Laboratory of Ophthalmology, Harvard University Medical School

Visual acuity while viewing a moving object is a matter which has received little attention. In fact, the only reference bearing remotely on this subject which I have been able to find is a note by Irving Langmuir (*1*). Dr. Langmuir has ingeniously demonstrated that the speed of 818 miles/hour attributed to the deer botfly by the *Illustrated London News* (*4*) is excessive. As Dr. Langmuir expresses the matter, the insect must consume "1.5 times his own weight of food each second" in order to maintain this velocity.

To establish the approximate speed of the fly, Dr. Langmuir conducted an experiment which he describes as follows:

"... I took a short piece of solder about 1 cm. long and 0.5 cm. diameter and tied it about its middle to one end of a light silk thread, holding the other end in my hand. With lengths of thread of from 1 to 3 feet it was easily possible to swing the weight in a circle in a vertical plane at the rate of 3 to 5 rotations per second (timed with a telechron clock).

[1] This investigation was supported in part by a grant from the American Optical Company.

In this way speeds from 13 to 64 miles per hour were produced.

"Observations in a room, with a brightly lighted white ceiling as background, showed that at 13 miles per hour (580 cm./sec.) the 'fly' was merely a blur—the shape could not be seen, but it could be recognized as a small object of about the correct size.

"At 26 m./hr. (1,150 cm./sec.) the fly was barely visible as a moving object. . . ."

He concludes that "a speed of 25 miles per hour is a reasonable one for the deer fly."

It may well be that energy considerations limit the speed of the deer fly to a mere 25 miles/hour, but I wish to give evidence indicating that the fly would be visible at much higher linear velocities. Neither the article in the *Illustrated London News* nor the original article by Dr. Townsend (*2*) states at what distance the fly was observed. Had Dr. Langmuir been able to produce similar rotations with a thread 94 instead of 3 feet long, it seems likely that his artificial "fly" would have been visible though traveling at over 100 miles/hour. The reason is that the acuteness of human vision is diminished not by the linear, but by the angular, velocity of the object viewed.

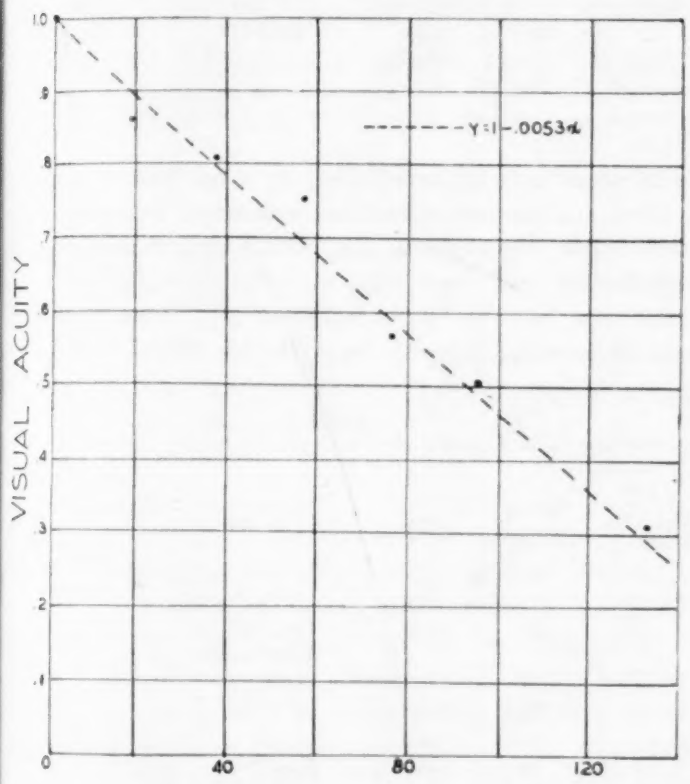

FIG. 1

The data presented in Fig. 1 show some results I obtained during a general experimental investigation of visual acuity while viewing a moving object. The data are for constant angular velocity in the horizontal plane. The test objects were Snellen letters.

The expression $y = 1 - .0053x$ is a fair empirical fit to the data. A stationary black disc on a white background can be seen when it subtends an angle of 25–30″ of arc at the eye, and the corresponding value for a stationary black line on a white background is 4–6″ of arc (*3*). The artificial fly presents a roughly rectangular cross section to the eye, and we may assume an intermediate value of 18″, or .005°, as the angle necessary for vision when the fly is stationary. The angle necessary for vision when acuity is reduced by moving the fly is, then, $\beta = \frac{.005^\circ}{1 - .0053\,\alpha}$, where α is the angular velocity in degrees per second. This velocity equals approximately $57.3\,\frac{v}{r}$, where v is the linear velocity in feet per second and r the distance to the object in feet. The angle, θ, subtended by the fly, is approximately $57.3\,\frac{s}{r}$ in degrees, s being the size of the object in feet.

For visibility, $\theta = \beta$, or $57.3\,\frac{s}{r} = \frac{.005^\circ}{1 - .304\,\frac{v}{r}}$. From this, $v = 3.29\left(r - \frac{.005\,r^2}{57.3\,s}\right)$ and $\frac{\partial v}{\partial r} = 3.29\left(1 - \frac{.01\,r}{57.3\,s}\right)$. It appears that the highest velocity with good visibility will occur when $r = 5{,}730\,s$. Taking Dr. Langmuir's value of .5 cm., or .0164 feet, for s, we find that the optimum distance for observation of the fly is 94 feet. At a distance of 3 feet, the fly would begin to blur at about 7 miles/hour, a figure in substantial agreement with Dr. Langmuir's observations. However, at a distance of 94 feet and with contrast and other conditions of vision optimal, the deer fly might be seen while traveling at 105 miles/hour, if it can fly that fast.

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Production of Yellow Bean Mosaic in Beans by Virus From Mottled Gladiolus

F. P. MCWHORTER, LYTTON BOYLE, and B. F. DANA[1]

Oregon State College, Corvallis

The first observation conducive to this record of an improbable source of Bean Virus 2 was made by Carl Robertson, of the Eugene Fruit Growers Association, Eugene, Oregon. In 1939 Mr. Robertson asked local pathologists interested in vegetable diseases to observe a field of *Phaseolus vulgaris* L. var. Blue Lake, planted contiguous to a field of *Gladiolus* spp. He wished confirmation of his observation that a gradient infection of mosaic extended from the row nearest the gladioli to a distance of approximately 150 feet, and of his opinion that the gladioli were the probable source of the virus. While the correlation between high mosaic percentage in the bean planting and the nearness of gladiolus plants was amazing, we supposed the apparent correlation was nonsignificant, having found an occasional mosaic-diseased clover plant in

[1] Published as Technical Paper No. 477 with the approval of the director, Oregon Agricultural Experiment Station. Contribution of the Department of Botany in cooperation with the Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture.

the vicinity. Subsequent observations and tests have proved that Mr. Robertson's surmise was correct.

During later years we have observed this same Bean Virus 2 correlation whenever snap beans were exposed to commercial plantings of gladioli. Two 1945 occurrences are illustrative. A two-acre commercial test of varieties of *P. vulgaris* for canning was planted in a portion of a large, well-tilled field near Salem, Oregon. There were no other legume crops in the area nor any apparent usual sources of Bean Virus 2. One end of the bean field was exposed to a five-acre planting of gladioli growing weed free in exceptionally good culture. The rows of beans ended about 15 feet from the gladiolus plants. An extremely severe infection of yellow bean mosaic began early in the season at the end of the planting next to the gladioli and developed into a gradient infection extending away from them to a distance of about 200 feet. All the bean plants within 50 feet of the gladioli were ruined by the mosaic. The second case occurred in a field near Portland. Two rows of snap beans, each approximately 150 yards long, were planted parallel to, and 20 feet from, rows of gladioli in a commercial field. At the end of the bean rows, and equally exposed to the gladiolus plants, was a planting of Lima beans, *P. lunatus* L. All of the snap beans and none of the Lima beans were dwarfed by necrotic and mottle strains of yellow mosaic. The significance of this field evidence is enhanced by the fact that we have been unable to prove seed transmission for any strain of Bean Virus 2.

During the war years a serious virus disease of snap beans appeared in Oregon. This disease is characterized by various necrotic symptoms which, in extreme cases, lead to the death of young plants. An investigation of this disease (*1*) and of yellow mosaic commonly associated with it has shown that the necrotic symptoms and death of plants are caused by strains of Bean Virus 2. Yellow mosaic appears to be due to a complex of Bean Virus 2 strains. Some of these have modified properties, but all form specific cytological evidence (*2*) in the foliar cells of *Vicia Faba* L. During the investigation we tested commercial gladiolus plants as sources of the yellow mosaic complex. Preliminary inoculations to *P. vulgaris* L. var. Blue Lake by the carborundum method (*3*) were not conclusive. Later trials, using plants of *V. Faba* L. as inoculates, gave transfers of 1/8, 1/9, 0/12, 0/12, 0/12, 0/20, 2/44, 0/9, 1/10, thus giving positive transmission in four out of nine trials. These cross-inoculations were made with precautions and controls that make these low percentages of transfer significant. The isolations from gladiolus included not only the typical yellow bean mosaic but also some of the necrotic types. It is very probable that the numerous plantings of gladioli in western Oregon, where beans are grown for canning, may have played some definite role in the recent epiphytotic of virulent strains of Bean Virus 2. The details of this investigation will be reported elsewhere.

All the gladiolus foliage used for preparing inocula had the usual mottle characteristic of gladiolus mosaic in commercial plantings. No virus-free gladiolus plants were available to determine whether gladiolus mosaic can be induced by inoculating gladioli with Bean Virus 2 from beans.

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Production and Treatment of Hepatitis With Focal Necrosis of the Liver in White Mice

Paul Engel

Laboratorios Hormona, Bogotá, Colombia

Different series of white mice were treated during various weeks with coal tar, an area of about 1½ cc.[2] being painted every second day. Some of the animals died in the first days; most of them, after 2–6 weeks. In the livers of these animals were found small, well-determined yellow spots.

Histological examination[1] revealed hepatitis and acute congestion of the organ, with zones of focal necrosis, some of them small and others extending over different lobes. In the portal areas there appeared a leucocyte reaction, with cloudy swelling and nuclear alterations, especially cariorrhexis. No other organ was affected. The percentage of animals with liver damage was rather high, as indicated in Table 1.

TABLE 1

Series No.	No. of animals	Sex	Treatment	No. of animals	
				With liver damage	Without liver damage
1	40	male	Coal tar	22	18
2	15	female	"	8	7
3	24	male	"	14	10

Sato and, later on, Forbes and Neale (*1, 2, 4*) have described antitoxic substances in the liver. In this laboratory we have studied the influence of liver extracts on the coal-tar-produced liver damage, using a concentrated, sour, aqueous liver extract, which had been made protein free by alcohol precipitation, and 0.1 cc. of which corresponded to 3 grams of fresh beef liver. The animals were painted three times a week with coal tar and also received injections of the liver extracts three times a week. As controls, various series of mice were treated: two series only with coal tar, and two others with

TABLE 2

Series No.	No. of animals	Sex	Treatment	No. of animals	
				With liver damage	Without liver damage
4	23	male	Coal tar	0	23
5	20	"	Liver ex'ract "	2	18
6	20	female	"	2	20
7	31	male	"	0	31
8	10	female	Coal tar	4	6
9	14	male	"	9	5
10	6	"	Coal tar	5	1
11	10	female	Histamine Coal tar	2	8
12	16	male	Vitamin B "	9	7

[1] The author is indebted to Dr. Augusto Gast Galvis, of the Instituto de Estudios Especiales in Bogotá, for the histological studies of the livers.

vitamin B complex because of the influence of vitamin B, and especially of riboflavin, on different liver functions (*5*). Three times a week these animals received injections of 0.1 cc. of a product containing 0.2 mg. of riboflavin, 0.1 mg. of thiamine chloride, and 1 mg. of nicotinic acid. Finally, one series was treated with 0.1 mg. of histamine every second day. Our liver extract was not entirely free from histamine, and this substance could, by closing the hepatical veins (*3*) influence the origin of hepatical damages. Table 2 shows the results of these experiments.

From these results the protective influence of concentrated liver extract seems evident, while vitamin B seems to exert very little protective influence. Probably the active principle in the liver is related to the antinecrotic substances described by Forbes and Neale. In future research these relations are to be studied.

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Forty-Five Years of Continuous Cropping With Lima Beans

Francis L. Smith, A. H. Holland, and John H. MacGillivray

College of Agriculture, University of California

The declining yields resulting from continuous cropping, which has generally been regarded as inadvisable, have usually been with nonleguminous crops. The gradual decline in wheat yields under a single cropping system in California eventually made the practice unprofitable. Experimental data on continuous cropping, accumulated from the Morrow plots (*1*) at Urbana, Illinois, have shown that corn grown continuously showed a gradual decline, the yields averaging 39.7 bushels/acre from 1888–1903 and 24.5 bushels from 1904–44—a decrease of 38 per cent. On the Sanborn field (*3*) in Missouri, there was a 39 per cent decrease in yield of timothy in the second half of a 50-year period, a 12 per cent decrease in the yield of corn, and a slight increase in wheat. However, this report indicates that recently the continuous wheat plot has produced satisfactory crops only in alternate years. Experimental work on continuous cropping in California (*2*) was conducted for only 10 years. Various nonlegume crops were used. In the cultivated crops of milo, the second 5-year period showed a decrease of 51 per cent. The yields of barley were reduced 55 per cent; rye, 43 per cent; wheat, 42 per cent; and oats, 54 per cent. In the noncultivated cereal crops, weed growth, which could be controlled in the milo plots, may also have been a factor.

In the dry Lima bean area in California, centered in Ventura County, growers have not experienced such declines. The general practice is often to plant Lima beans on the same land year after year. On one field a continuous record is available from 1901 to 1945, with the exception of 1902, when the records are not complete. This field, which consists of 235 acres, was purchased by the Samuel Edwards Associates[1] in 1882 and since then has been under continuous management of the family. Barley was probably grown prior to 1882 and large Lima beans since that time although no yield records are available prior to 1901. The soil is Yolo loam. In the early days, when the beans were threshed with stationary threshers, the straw piles were burned. Later, when orcharding came in, the straw was sold to orchardists for a winter cover. Since 1938, when the pickup threshers came into use, the straw has been scattered in the field as the beans were threshed. Irrigation after planting was not practiced until 1921. However, previous to 1921, in years of short rainfall, the land was irrigated before planting. Since then, a 4- to 6-inch application of water has been made in June or July to insure adequate moisture. During this period, with the widespread use of power equipment, other changes in farming practices have been made, one of these being to plow the dry land deeply in the fall.

At harvest, the beans were threshed, sacked, and hauled to the warehouse. The yields of the Edwards field were calculated from the receiving weights at the warehouse. The cleanout averaged 3–4 per cent. The 45-year yield record from this field is shown graphically in Fig. 1. From 1900 to

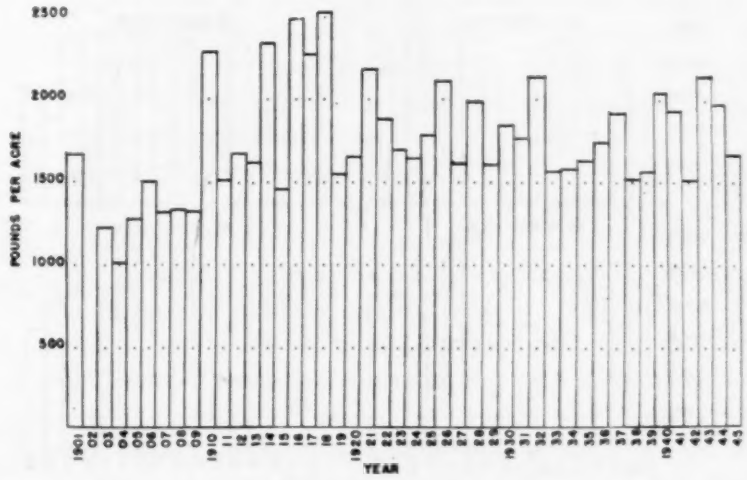

Fig. 1. Yield record of Lima beans grown continuously for 45 years on a 235-acre field in Ventura County, California.

1942 the Lewis variety, or selections from it, was used; since 1943 the Ventura variety has been planted. The lowest yield, 1,018 pounds/acre, was obtained in 1904; the highest, 2,533, was obtained in 1918. The averages of the nine 5-year successive periods were 1,283; 1,553; 1,717; 2,100; 1,856; 1,836; 1,746; 1,751; and 1,827 pounds/acre. An analysis of variance showed that the variance between periods was not significant. The F value was 0.46. There was no correlation between rainfall and yield; therefore, other important factors, such as temperature, pests, diseases, and perhaps humidity, were the causes of yearly yield variations. Both wireworms and nematodes have caused some reduction in yield during some years. Because of losses from wireworms, the rate of planting has been increased from 40 pounds/acre to 80 or more in recent years. The average yield of the 45-year period

[1] These data were made available through the kindness of the Samuel Edwards Associates, Santa Paula, California.

was 1,751. Since 44 crop years are represented, there are two 22-year periods. The average yield of this first period, ending in 1923, was 1,717 pounds/acre; that of the second period, 1924–45, 1,786 pounds/acre. Continuous cropping has therefore not resulted in any loss of yield of Lima beans in this 45-year period.

To substantiate the data from the Edwards field, interviews with officials, cooperative associations, and others familiar with local farming practices were made. These interviews indicate that continuous cropping of Lima beans for 15–25 years is rather common. The yield records of four growers who had practiced continuous cropping for a period of 16 years were obtained and are presented in Fig. 2. The 16-year period was divided into two 8-year periods. The average of the first period was 2,173 pounds/acre; that of the second, 2,224.

Prof. W. W. Mackie, emeritus agronomist of the California Experiment Station, who has been a close observer of the Lima bean industry for many years, wrote in a recent letter: "Continuous yields of large Lima beans have been observed by me many times in the Ventura area on irrigated land. On the dry mesa or hilly soils in Ventura and San Diego Counties this condition does not always follow, due to lower soil fertility of the hilly residual soils and often to an absence of nodule forming bacteria."

Some fertilizer experiments have been conducted on small

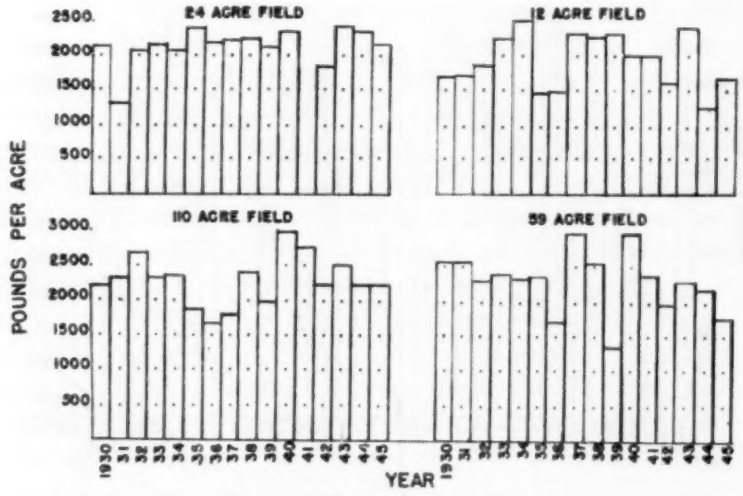

FIG. 2. Yield record of 16 years of continuous cropping with Lima beans on four independent fields in Ventura County.

plots in the Edwards field. In 1937 liquid ammonia was applied on three plots at the rate of 62 pounds of nitrogen/acre and on three at the rate of 82 pounds of nitrogen/acre. There was no difference in yield between the unfertilized check plots and those receiving the lighter application of ammonia. With the heavier application there was a barely significant increase of 117 pounds/acre ($P = .05$).

In 1942, 1943, and 1944 fertilizer experiments were conducted on replicated plots, 20 x 100 feet. The fertilizers were applied as side dressings 6 inches from the planted bean rows. The three treatments used were: (1) 84 pounds and (2) 168 pounds of phosphoric acid (P_2O_5), as well as (3) both 168 pounds of phosphoric acid and 100 pounds of nitrogen/acre. The phosphoric acid was supplied by treble superphosphate, and the nitrogen by ammonium sulfate. There was significant increase in yield only when both nitrogen and phosphoric acid were added. This fertilizer application gave an increase in yield of 239 pounds of beans/acre in 1942, 415 pounds in 1943, and 560 pounds in 1944. The least significant differences in pounds/acre were 198 in 1942, 287 in 1943, and 409 in 1944.

This evidence indicates that on rather fertile soil, Lima beans do not decrease in yield when continuous cropping is practiced. This may be partially explained as the replenishment of the available nitrogen supply by the Lima bean nodules. The other essential elements must be in abundance.

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Role of the Axis Cylinder in Transport of Tetanus Toxin[1]

PAUL G. ROOFE

Department of Anatomy, University of Kansas

The purpose of this article is to show that the neurofibrillae in the axis cylinder are the agents responsible for the transport of tetanus toxin to the cell bodies of motor nerves. In this transport the rate of progression has been measured and will be stated below. The chief interest in this problem is primarily to add one more fact to our knowledge of the physical and chemical nature of the neurofibrillae. Howe and Bodian (*2*) have stated that the axis cylinder is the route taken by the virus in experimental poliomyelitis in monkeys. Their method of freezing the sciatic nerves was used in the experiments outlined below. Friedemann (*1*), in discussing the blood-brain barrier, states that the capillaries of the central nervous system are impermeable to tetanus toxin. In this article he also lists the literature dealing with the controversial subject of blood stream versus neuron routes taken by the tetanus toxin. The experiments here listed substantiate the nerve-fiber route.

After carefully exposing and severing the sciatic nerve very close to the knee joint, 8 guinea pigs were inoculated with a tetanus toxin which had 75,000 m.l.d./cc. The inoculation was made in the following manner: The central cut end of the sciatic nerve was held firmly against the end of an applicator stick which had been dipped in the tetanus toxin of the above-mentioned strength. The time of exposure in each case was 5 minutes. The end of the applicator stick did not hold a drop of the toxin but was merely moist. All of the guinea pigs were dead within 72 hours. Their death was due to tetanus, the symptoms of which were those of the local type. First to show signs of stiffness was the opposite limb, then the lower back, thoracic level, and finally the cervical and head region. The wound was closed surgically under strict aseptic conditions.

On 8 other guinea pigs the sciatic nerve was exposed and frozen with CO_2 snow as far centrally as was conveniently possible. This technique produces the degeneration of the axis cylinder but does not alter the blood supply or the neurilemma sheath. The frozen area is about 2 mm. in length. Sixteen days

[1] Present address of author: University of Louisville. Tetanus toxin supplied by courtesy of Eli Lilly and Company, Indianapolis.

later the same sciatic nerve in each animal was inoculated as described above. Two of the animals died on the fourth day of undetermined cause, showing no signs of tetanus. The other six were sacrificed on the sixth day after inoculation. The toxin failed to reach the central nervous system because of the degeneration of the axis cylinder.

Another series of 8 guinea pigs was inoculated in like manner without freezing. Four of these received .5 cc. of tetanus antitoxin subcutaneously 10 minutes previous to the inoculation. The other four were given 0.1 cc. of the antitoxin into the sciatic nerve central to the cut end immediately after inoculation. All 8 of these animals were sacrificed 14 days later without any signs of tetanus. No attempt has been made to freeze the nerve and then allow for regeneration of the axis cylinder before inoculation.

The average length of the central stump of the sciatic nerve was 57 mm. The average time from inoculation until the opposite limb began to show tetany was 17 hours. Assuming that the tetanus toxin travels uniformly up the axis cylinder, the rate of progression then is 3.35 mm./hour. No attempt has been made to determine the method by which the toxin ascends the nerve fiber.

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Therapy of Experimental Tsutsugamushi Disease (Scrub Typhus)[1]

LT. (JG) W. F. MCLIMANS, H (S), USNR,
and LT. C. W. GRANT, H (S), USNR[2]

Naval Medical Research Institute,
Bethesda, Maryland

Tsutsugamushi disease (scrub typhus), an acute febrile disease of the Asiatic areas, became of major military importance during the war in the Pacific theater. It was late in 1943 that the first strain of the etiological agent, *Rickettsia tsutsugamushi*[3] (Karp), was obtained by the U. S. Navy[4] for study in this country. At that time an investigation was begun to determine possible therapeutic agents that might be used in combating the experimental infection in Swiss mice.

It was observed during the course of these experiments that mice inoculated intraperitoneally with the Karp strain of *R. tsutsugamushi* and subjected to elevated oxygen tension, whether at sea level or increased pressure, showed a decreased mortality.

In a typical experiment 90 mice were inoculated intraperitoneally with 1,000 m.l.d. of the Karp strain. Immediately after inoculation, one group of 30 mice was placed in a standard oxygen tent and subjected to an oxygen tension of 50 per cent

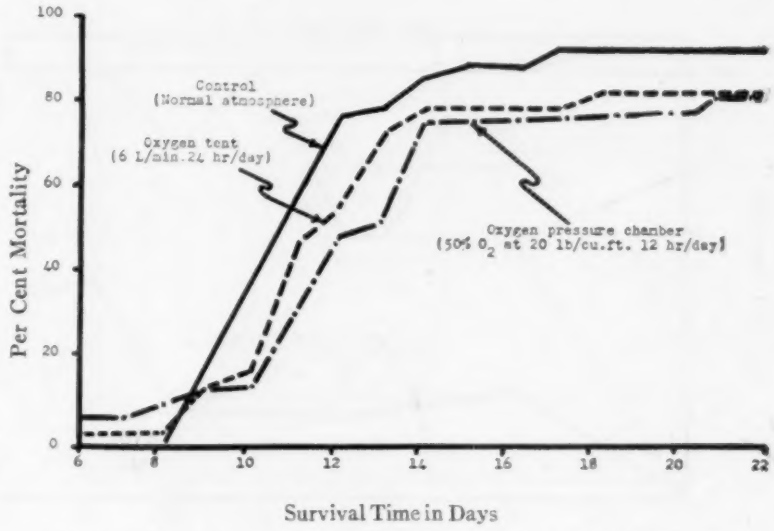

FIG. 1. Effect of oxygen tension upon the survival time and mortality of *R. tsutsugamushi* (Karp) infected mice.

maintained by a flow rate of 6 l./minute; a second group of 30 mice was placed in a pressure chamber containing 50 per cent oxygen in nitrogen at 20 pounds pressure; and a third group of 30 mice was kept under normal atmospheric conditions. It will be noted that increased oxygen tensions had a slight yet consistently beneficial effect on the survival time and the mortality of infected mice (Fig. 1).

On the basis of the action of this physiological factor it appeared advisable to test a series of agents for therapeutic activity under both environmental conditions—normal atmosphere and 50 per cent oxygen.

The institution of therapy was always delayed for at least 96 hours following inoculation of the mice. This period represented, as previously shown (*3*), the time usually required for the blood of mice inoculated with 1,000 m.l.d. of the Karp strain to become infective in sufficient titer to kill passage mice. It was thus assumed to be that period in the course of the infection which closely represented the end of the incubation period. Therefore, agents which proved to be efficacious when treatment was delayed for at least 96 hours could be classed as therapeutic rather than prophylactic.

The therapeutic agents were administered orally by mixing them intimately with the normal diet of ground fox chow.

One agent, methylthionine chloride (methylene blue), in contrast to the others, proved to be remarkably effective in combating the infection in Swiss mice under these conditions. It was observed that 0.2 per cent methylthionine chloride (MTC), added to the diet 96 hours following inoculation of the mice, reduced the mortality to 30–40 per cent, as contrasted to a 90–100 per cent mortality for the untreated controls. When oxygen therapy was instituted in conjunction with MTC, the mortality of the treated mice was further reduced to 20–30 per cent.

MTC has been used as a therapeutic agent in such diverse human infections as gonorrhea, tympanosomiasis, malaria, etc. (*1*). It has also been reported as an active agent in the

[1] The opinions or assertions contained herein are the authors' and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large. This paper is based on a report of the authors entitled "Studies in tsutsugamushi disease. II: Experimental therapy of the infection in Swiss mice" (U. S. Naval Medical Research Institute, Research Project X-222, Rep. No. 2, November 9, 1944).

[2] Present addresses: Departments of Bacteriology, University of Minnesota and Brooklyn College, respectively.

[3] R. Lewthwaite has made a comprehensive survey of the literature regarding the correct nomenclature for the etiological agent of this disease and has recommended *R. tsutsugamushi*. Personal communication.

[4] This strain was isolated by F. M. Burnett, Royal Melbourne Hospital, Victoria, Australia.

therapy of experimental murine typhus infections in Swiss mice (*4*) and guinea pigs (*2*).

Since p-aminobenzoic acid (PABA) had previously been shown by Snyder, *et al.* (*5*) to be effective in the therapy of mice infected with the etiological agent of endemic typhus, an effort to determine the relative efficacy of MTC and PABA in

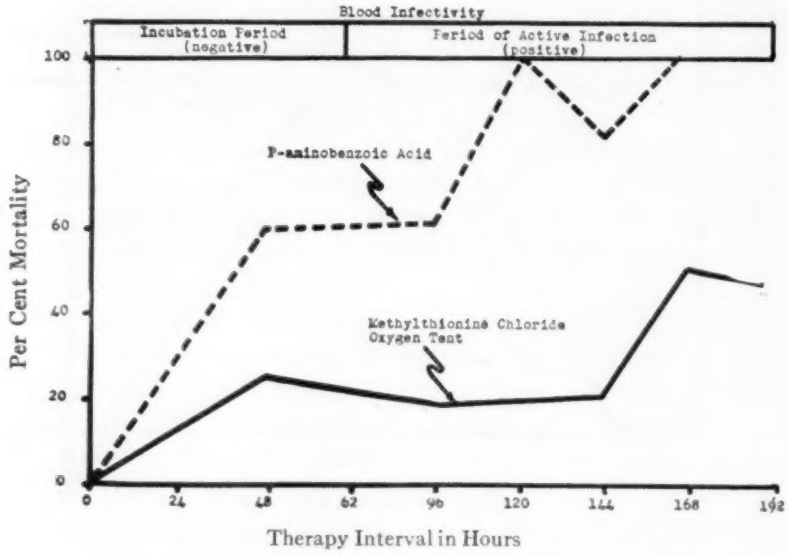

FIG. 2. Relative efficacy of MTC and PABA in *tsutsugamushi* (Karp) infected mice. Therapy interval indicates the elapsed time between inoculation of the mice and institution of therapy.

experimental *R. tsutsugamushi* infections was made. The concentrations of the two drugs in the ground fox chow were made equivalent—0.4 per cent. Institution of therapy was delayed for various time intervals up to and including 192 hours postinoculation. The results of this experiment (Fig. 2) show that while PABA was no longer effective when institution of therapy was delayed for more than 120 hours, MTC plus oxygen was still partially effective even when treatment was delayed up to 192 hours. Furthermore, the per cent mortality

TABLE 1

EFFECT OF MTC, MTC PLUS OXYGEN, AND PABA ON THE AMOUNT OF PERITONEAL FLUID FOUND ON AUTOPSY

Agent	No. of mice	Percentage of mice showing graded amounts of peritoneal fluid*				
		Neg.	+	++	+++	++++
MTC (normal atmosphere)	56	39.2	44.7	13.6	0.0	2.3
MTC (oxygen)	26	44.0	32.1	19.5	4.5	0.0
PABA	43	4.1	30.5	32.7	19.2	13.1
Control (untreated)	44	9.1	15.9	45.4	15.9	13.6

* Peritoneal fluid graded as neg. = none; + = 0-0.2 cc.; ++ = 0.2-0.5 cc.; +++ = 0.5-1.0 cc.; ++++ = greater than 1 cc.

in all instances was significantly lower in the group treated with MTC.

When the concentration of PABA was increased to 1 per cent, its effectiveness as a therapeutic agent in the experimental infection increased but still was not of the order of magnitude of MTC.

Peritoneal fluid, one of the predominant gross pathological signs found at necropsy of untreated mice, was significantly reduced in quantity in the MTC-treated mice that died. In this respect, PABA-treated mice and the untreated control mice closely paralleled each other (Table 1).

In view of the well-established functions of MTC as an oxygen carrier and as a catalyst of numerous enzymatic reactions, studies on the mechanism of the action of this drug in the subject infection may reveal principles underlying the effective chemotherapy of virus and rickettsial diseases. Such studies are under way at this Institute.

These results clearly establish the beneficial effect of methylthionine chloride as a therapeutic agent in the treatment of *R. tsutsugamushi* infections in Swiss mice and the synergism of the drug with oxygen in such infections.

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Insecticidal Action of 1-Trichloro-2,2-Bis-(p-Bromophenyl) Ethane (Colorado 9)[1]

GEORGE M. LIST and MERLE G. PAYNE

Colorado Agricultural Experiment Station, Fort Collins

The compound made by condensing one molecule of chlorohydrate with two molecules of bromobenzene is 1-trichloro-2,2 bis(p-bromophenyl) ethane (*4*), which has been designated as Colorado 9. This has had a definite killing effect on certain insects and, like its relative, DDT, is stable and does not have an unpleasant odor.

Colorado 9 kills flies at the low spray level of 0.1 ml. of 5 per cent petroleum solution per cubic meter of air space. The flies lose their motor ability after 10 minutes and die within an hour. Early in 1945 it was determined by laboratory tests that Colorado 9 was lethal for the potato and tomato psyllid, *Paratrioza cockerelli* Sulc. During the growing season the material was used in potato plot tests by dissolving it in xylene at the rate of 1 pound to 1 quart of xylene and emulsifying by adding 1 part Triton 100 X to 50 parts of the above mixture. The spray solution carried 1 pound of Colorado 9 to 100 gallons of water. Five applications were made during the season, the usual schedule followed for psyllid control. At no time were any indications of plant injury from the spray applications detected. The variety of potato was the Irish Cobbler.

The yield of potatoes of marketable size (1⅞ inches in diameter or larger) has been found to be the most reliable measure of successful psyllid control. The treated plots yielded at the rate of 313.2 bushels/acre; untreated plots, at the rate of 22.8 bushels.

Colorado 9 was again used in plot tests in 1946 and at mid-

[1] Published with the approval of the director as paper No. 223, Scientific Journal Series, Colorado Agricultural Experiment Station.

This compound was synthesized in November 1944 by Merle G. Payne and E. L. Bailes. The latter, at that time a member of the chemistry section of the Colorado Experiment Station, has since resigned.

season gave indications, as determined by weekly sweepings by means of the insect net, of promising control of psyllids, tuber flea beetles, and leaf hoppers.

In studying a new approach to the control of the European elm scale, *Gossyparia spuria* (Modeer), it was found that Colorado 9 was definitely lethal to this insect.

The insecticide DDT, when used on leguminous plants at high concentrations, has a definite depressing effect on the bacterial nodules (*1*). In agricultural crop rotation where legumes are grown for increasing the soil nitrogen, this was a distinct disadvantage for DDT. Colorado 9 has the advantage of having no depressing effect at high concentrations on bacterial nodules of legumes when used as an insecticide (*2, 3*). Extensive field investigation indicates that there was no injurious effect when insecticidal preparations using this compound were sprayed on plants.

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Lesions of the Pancreatic Islets Produced in Cats by Administration of Glucose

F. C. Dohan and F. D. W. Lukens

George S. Cox Medical Research Institute, University of Pennsylvania, Philadelphia

Previous studies (*1*) have suggested that an elevated level of blood glucose may, under certain circumstances, result in lesions of the islands of Langerhans. Thus, in animals with subtotal pancreatectomy or in those treated with anterior pituitary extract, a period of hyperglycemia precedes hydropic degeneration of the beta cells. Furthermore, measures which lower the blood glucose (e.g. diet, insulin, or phlorizin) will prevent or reverse such changes during the early stages. The literature concerning the effect of the administration of glucose upon the pancreatic islets reveals either failure to secure prolonged hyperglycemia in dogs or the occurrence of only minor changes in granulation of the beta cells of other species.

It has been found possible to elevate the level of blood glucose in cats by means of repeated intraperitoneal injections of glucose. Twenty per cent glucose in physiological saline was given at approximately 8-hour intervals, the amount injected being gradually increased from 50 to as much as 140 ml./dose (150–420 ml. daily). The amount of food eaten and the urine glucose excreted were determined daily. Extra vitamins, particularly thiamine, were administered in large amounts. Blood glucose determinations were made at frequent intervals, usually just before the intraperitoneal injection of the glucose-saline solution. Normal cats and four cats from which approximately half to two-thirds of the pancreas had been removed were employed. These were observed for several weeks before starting the glucose injections and were known to have normal blood glucose concentrations.

After a few days of injections some of the cats exhibited a syndrome of marked weakness of the hind legs, ataxia, anorexia, occasional convulsions, and death—an effect noted by others in dogs and cats. However, some of the cats did not develop this syndrome, or recovered from it so that injections could be continued for weeks.

TABLE 1

No. of cats*	Total period of glucose injections		Days of hyperglycemia‡	Hydropic degeneration of beta cells
	Days	Avg. blood sugar† (mg./100 ml.)		
4	14–27	209–326	9–19	Marked
4	6–16	133–296	0– 5	None

* Each group consisted of two normal and two partially depancreatized cats.

† Average of all blood glucose determinations made just before injections of glucose.

‡ Morning hyperglycemia indicates a blood glucose concentration of greater than 149 mg. per cent prior to the 8:00 A. M. injection of glucose.

To date, sections of the pancreas of 8 animals have been examined, and the histological changes in the islands of Langerhans have been related to the degree and duration of hyperglycemia (Table 1). The morning preinjection blood glucose value has been selected as a criterion because more observations were made at this time and, in the great majority of instances, it was the lowest preinjection value in the 24 hours. This was due to the fact that this sample of blood was usually obtained at a somewhat longer interval after the previous injection of glucose.

In addition to these animals, a normal cat was maintained hyperglycemic for a period of 39 days by means of glucose injections. When these were stopped, the cat remained severely diabetic. It was sacrificed while in diabetic acidosis 22 days after the last injection. Prior to death it had excreted approximately 100 per cent of the available glucose of the meat diet and had developed acetonuria. Terminal blood samples showed greatly increased concentrations of glucose and fatty acids, and the serum CO_2 was 11 vols. per cent.

Summary. Hydropic degeneration of the islands of Langerhans and permanent severe diabetes mellitus have followed the prolonged injection of intraperitoneal glucose-saline solution in normal as well as in partially depancreatized cats. Positive results were associated with prolonged hyperglycemia. These findings add further evidence in support of the hypothesis that a sustained elevation of blood glucose may, under certain conditions, lead to the production of damage to the islands of Langerhans in this species. Besides hyperglycemia, other disturbances which might be responsible wholly or in part for the island lesions are under study.

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IN THE LABORATORY

A Technique for Aeration of Sterile Liquid Culture Medium

GORDON E. HUNT

Department of Botany, Cornell University

Sterile aeration of liquid culture medium can be accomplished simply by inserting a sterile tube through the cotton plug at the mouth of the tube and introducing sterile air through this tube. This method, however, does not allow for convenient manipulation of the culture flasks, making transfers, or moving the flask from the sterile air connection. In order to provide a more convenient and efficient means of aerating sterile root cultures the flask illustrated in Fig. 1 was constructed.

Sintered glass filters were prepared according to the method

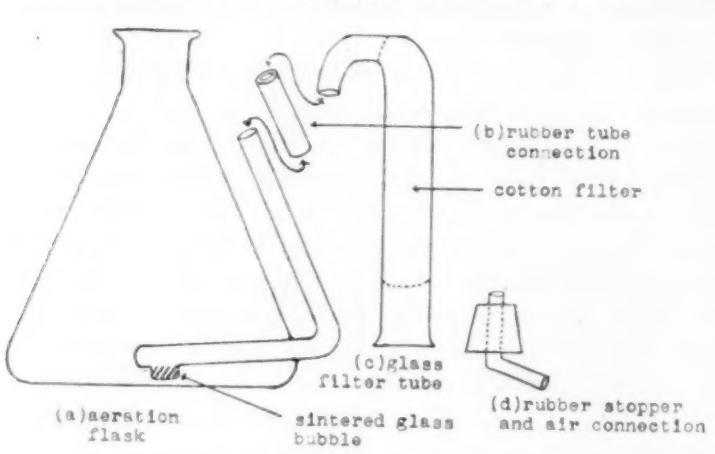

FIG. 1

of Kirk, Craig, and Rosenfels (*1*) and fused to the inside wall of the Erlenmeyer flasks as illustrated (a). An external arm, long enough to allow ample room for the culture medium to flow out without overflowing if the air pressure were cut off, was fused in place at the exit of the filter tube and bent up about parallel to the side of the flask. The sintered glass bubble was placed, open face down, in about the center of the flask bottom. Erlenmeyer flasks (250 ml.) were used.

To provide sterility, a glass tube was made in the shape shown (c), filled with cotton, and fitted with a one-hole rubber stopper and glass tube (d) in the outer end and a rubber connection (b) on the small end to hook to the glass side arm of the flask.

This flask was made and connected in sets of 10 to 14 with a glass manifold, the pressure and air flow in each flask being regulated with a screw clamp on the short rubber tube between the glass tube (d) and the manifold. Some special care had to be taken to attach the cotton filter tube to the side arm of the flask, but, once set up, the flasks were quite substantial. The cotton filter tubes were placed so that they lay against the flask. To avoid the danger of strains at the base, the flasks must be annealed well when the sintered glass filter tubes are inserted. It is also important to test the filters carefully for consistency in bubble size and porosity if the flasks are to be used in sets; otherwise, it is difficult to adjust the air flow evenly.

Further precautions were taken to ensure sterility by passing the laboratory compressed air used through a 2-l. suction flask of sterile water, protected on each side by glass, cotton-filled tubes (15 x 1 inches), before passing it into the glass manifold with the individual take-offs. The water, in saturating the air, prevented the cultures from drying out. Cotton plugs were used at the top of the flasks as usual. The air intakes may be detached and reconnected without contaminating the cultures.

Excised root cultures were kept sterile and aerated in these flasks over a period of three months and could have been kept longer if desired.

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Studies on the Stability of Streptomycin in Solution

E. J. OSWALD and J. K. NIELSEN

Division of Penicillin Control and Immunology, Food and Drug Administration, Washington, D.C.

In the process of developing satisfactory assay methods in this laboratory, preliminary studies have been made of the stability of the F.D.A. streptomycin working standard (*2*) when held in solution in different concentrations and at three pH levels. The working standard, which was established on November 20, 1945, has a potency of 400 μg. of activity/mg. when streptomycin base is assigned a value of 1,000 μg./mg. It was established early that streptomycin is considerably more stable in solution than penicillin, and it appeared to be particularly desirable to determine the most efficient concentration and pH level that could be utilized for the establishment of a working standard solution. Accordingly, the working standard was dissolved in sterile 0.05M potassium phosphate buffer at pH levels of 6.0, 7.0, and 8.0 in quantities sufficient to give solutions of 100 μg./ml. and 1,000 μg./ml. at each pH level. The two concentrations at each pH level were divided into 100-ml. amounts and tightly stoppered to minimize evaporation and chances of mold contamination. The solutions were held at 10°C. and assays[1] performed by both the turbidimetric and plate methods (*2*) every week for a period of three months. The data obtained were subjected to statistical

[1] These solutions were assayed against a standard solution prepared monthly to contain 100 μg. of the working standard/ml. in .005M potassium phosphate buffer—pH 6.

analysis, and it was shown that there was no appreciable drop in potency by either assay technique. Certain other variations, however, are worthy of mention.

In the specifications drawn up by the F.D.A. the final assay solution for the turbidimetric assay contains 100 μg./ml. of streptomycin. The 100-μg./ml. solution of standard streptomycin was therefore assayed undiluted, and the 1,000-μg./ml. solution was diluted 1:10 with distilled water to bring it to the proper

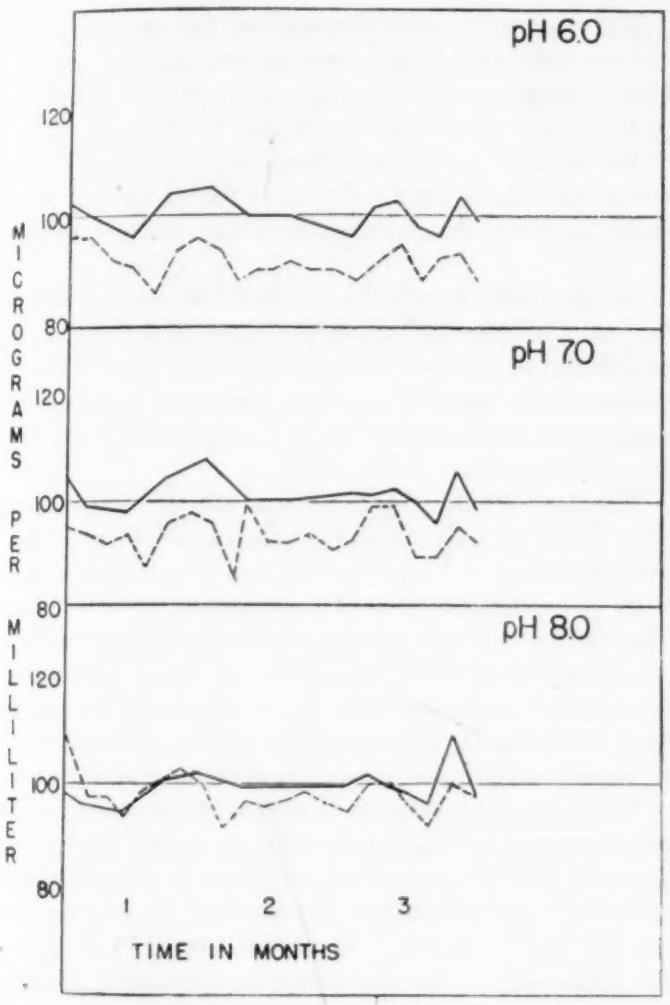

FIG. 1

assay dilution. This gave a 100-μg./ml. solution in 0.05M phosphate buffer and a 100-μg./ml. solution in 0.005M phosphate buffer at each pH level. The assay values obtained were as follows: At pH 6.0 the mean average of the 0.05M buffer concentration was 91.5 per cent activity and that of the 0.005M concentration, 100 per cent. At pH 7.0 the mean average of the 0.05M buffer concentration was 93.7 per cent activity and that of the 0.005M, 100 per cent. At pH 8.0 the 0.05M concentration showed 97.9 per cent activity, while the 0.005M buffer concentration showed 99.9 per cent activity. In other words, when the concentration of phosphate salts was increased, the activity of the streptomycin decreased, at least when that activity was measured by a turbidimetric method. The lowering of activity, however, was not the same at the three pH levels. At pH 6.0 the 100-μg. standard solution was 8.5 per cent lower than the 1,000-μg. standard; at pH 7.0, 6.3 per cent lower; and at pH 8.0, 2.0 per cent lower. The assay values are given in Fig. 1. The solid line represents the standard in .005M buffer (original, 1,000 μg./ml.), and the broken line represents the standard in .05M buffer (original, 100 μg./ml.). In three additional assays run turbidimetrically on these same solutions the 1,000-μg./ml. standard solution was diluted with 0.05M buffer instead of water. This had the expected effect of *lowering* the average assay figure for this solution closer to that of the 100-μg./ml. standard solution at all three pH levels. Apparently, a combined depressor effect is exerted on the activity of streptomycin by the increased concentration of buffer salts and the lowering of pH. Waksman (*1*) has demonstrated a similar restriction of the activity of streptothricin by buffer salts.

Summary. Streptomycin held in solution in concentrations of 100 and 1,000 μg./ml. at 10°C. is stable at pH 6.0, 7.0, and 8.0 for a period of three months. The depressor effect observed in the turbidimetric assay appears to be the result of two factors, buffer salt concentration and pH, and is most marked at pH 6.0. Almost normal activity reappears at pH 8.0 even in the presence of the greater concentration of phosphates.

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A New Type of Electroencephalographic Electrode Coordinator With Semipermanent Electrodes

MARVIN A. BUFFINGTON and ANDRE A. WEIL

The Neuropsychiatric Institute of Cleveland, Cleveland 6, Ohio

Gibbs (*1*) has made the statement that ideal electrodes for electroencephalographic purposes should not produce artifacts; should be easy to apply, keep on, and get off; and should be cheap and painless. Keeping these requirements in mind, most electroencephalographic laboratories employ enamel-insulated copper wires (usually 29- or 30-gauge), with the common solder-type pellets attached as electrodes. Unfortunately, this type of electrode can be used adequately only for 5–10 tracings and must then be replaced. In one way or another, a good deal of time on the part of the electroencephalographic laboratory personnel is therefore lost in the purely technical process of making and remaking electrodes. Furthermore, these commonly used electrodes frequently become tangled and bent because of their inherent mechanical characteristics, subsequently producing artifacts. Another point of difficulty is tracing the electrodes to their respective outlets at the terminal board.

Some workers (Ogilvie, *2*) have advised the use of "tinsel wire." In our experience, however, this carries too heavy a weight for the attachment on the scalp, and additional artifacts are produced by insufficient contact between the end of the "tinsel wire" and the silvered union which is commonly used.

It should be mentioned that a device for reducing the time to apply electrodes is the "headband electrode holder." This device, described by Ulett and Claussen (*3*), also avoids the use of collodion, depending entirely on pressure. However, an increased number of artifacts are unavoidable with this and

similar time-saving devices, due to complication of the mechanical technique.

In order to overcome these difficulties, we have tried to perfect a new coordinator (Fig. 1) which would (a) guarantee a long life for the electrode; (b) produce as few artifacts as possible; (c) guarantee segregation of the electrodes; (d) provide a permanent and yet accessible place of storage when not in use; and (e) allow the electroencephalographer a free, unobstructed view of the patient's head during the recording.

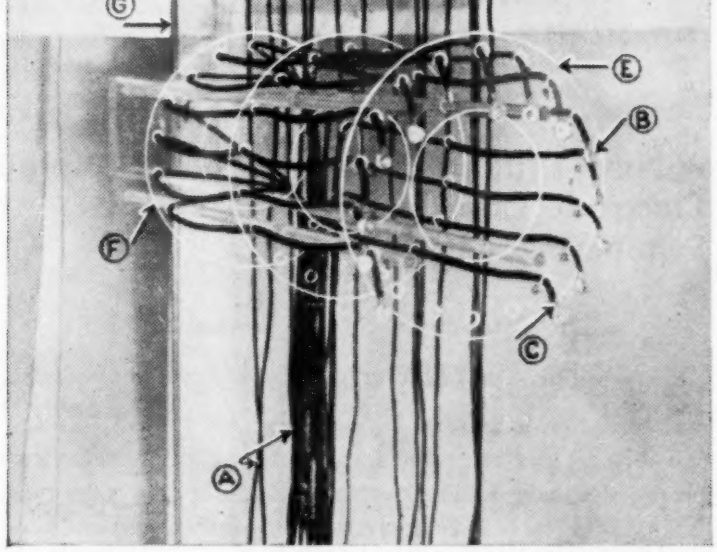

FIG. 1

The type of "wire" used for mechanical and electrical attachment to the electrode is that known as "tinsel wire" (A), consisting of a fabric sleeve-covered cord made up of strands of linen thread on which have been spun fine ribbons of copper. These strands are woven together to make a continuous, well-insulated cord of great strength and flexibility which has the same electrical characteristics as the type of solid wire generally used. The tinsel wire is bonded inside the soldered pellets (B) and sealed at the point of entry by an acetone-resisting tape (C), which insures the positive seal against corrosive elements, particularly acetone used in the technique commonly employed. The other ends of these wires are attached by "heat bonding" to plugs inserted in the terminal board (D) of the electroencephalograph. Since components of these plugs are removable without disturbing the bond to the wire, the wires may be removed or installed at will.

The heavy-weight factor of tinsel wire has been remedied by the use of a carrier or support, consisting of three circular flanges of $\frac{1}{8}$-inch flat lucite (E), supported in parallel, on vertical planes 6 inches apart, by a bridge of four lucite rods (F). The base is mounted on a vertical shaft (G) fastened to the frame of the cage. Thus, the whole contrivance is adjustable on a horizontal and vertical plane.

Each circular flange has 18 or more holes equidistant around its circumference so that the wires for the electrodes can be passed through the flange. These holes are large enough to permit free passage of the wires so that the ends to which the electrodes are attached may be extended through the vertical plane of the face flange to any desired length to fit the patient or adjust themselves to any sudden move of the patient. They can also be retracted easily, the electrodes then resting against the flange.

The other ends of the wires extend through the rear flange and are segregated to their various positions by means of the banana plugs attached. Approximately 4½ feet of slack is left to insure free movement through the bridge.

The numbers on the face flange, which segregate the electrodes, have been inscribed with India ink so that they can easily be removed and changed to suit different techniques.

Our electrodes have given extremely satisfactory recordings for 100–120 tracings, and some have lasted for over 140 recordings; no electrode had to be replaced prior to 100 applications. Unaccountable time was saved by avoiding the entanglement of electrodes and replacing those broken during the electroencephalographic process.

The type of wire used by us was tested in the laboratory. Most of the strands parted near the center of the cord at an average pull of 13.5 kg. The cord had not changed characteristics of conduction up to that point because the mechanical construction of the cord prevents any longitudinal stresses on the metallic strands. In further tests the cord withstood a 90° bend for an average of 250 times. Comparing the commonly used #29 solid, copper-enameled wire with electrode attached, we found that the wire parted at a maximum weight of 1.7 kg. at the point of entry to the electrode. This wire withstood a 90° bend only 5 times before breaking. It was also noted that the wire had changed characteristics due to stretching long before the maximum weight was reached. The measurement of the electrical resistance from the tip of the electrode to the tip of the plug on the end of the wire revealed .25 ohm for both types of electrode wires. Other electrical attenuation factors were negligible.

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Briquettes With Labels

ERNEST E. FAIRBANKS

U. S. Bureau of Mines, Tuscaloosa, Alabama

Detailed directions for the preparation of methyl methacrylate (lucite, crystallite, plexiglas, acryloid) briquettes accompany the laboratory presses especially designed for their production. In order to prepare a briquet in which a label has been inclosed it is necessary to modify these directions. The advantage of inclosing the label along with the specimen should be obvious: a number scratched into the plastic is

more difficult to prepare and decipher, while a neatly typed label on an ordinary white filing card is more readable and much easier to prepare.

The powdered acrylic resin is given an initial pressure of nearly 250 pounds. The resin is then heated to 125° C. When this temperature is attained, a pressure of 4,000 pounds per square inch (1-inch mold) is applied before removing the heater. This final pressure is maintained throughout the cooling period. The briquet is driven out at 75° rather than at 80° C.

Opaque, white, cloudy spots usually form if the older directions are followed with the label insert. The spots result from the retention of the inhibitor, which is readily driven off in spite of the label providing no pressure is maintained during the heating period.

Ultraviolet Radiation as a Means of Sterilizing Tissue Culture Materials[1]

J. Gordon Carlson, Alexander Hollaender, and Mary Esther Gaulden

Industrial Hygiene Research Laboratory, National Institute of Health, Bethesda, Maryland, and *Department of Biology, University of Alabama*

The efficacy of ultraviolet radiation of wave length 2,537 A. in killing bacteria, fungi, and viruses has been adequately demonstrated (*1*). It can be used, therefore, under certain conditions as a substitute for heat sterilization. If it is to be effective, however, certain requirements and limitations must not be overlooked. For sterilizing solutions containers of clear, transparent, fused quartz or of special glass transmitting wave length 2,537 A. must be used, because pyrex, plastics, and ordinary glass absorb this wave length. The surfaces of these containers and of dissecting instruments, slides, and cover glasses to be sterilized must be free of any extraneous matter that will absorb ultraviolet, and must be arranged in such a way in relation to the radiation source that all parts requiring sterilization are exposed to the radiation. Solutions must not contain in high concentration constituents that absorb appreciable amounts of ultraviolet radiation of this wave length, e.g. many organic substances—particularly proteins and sterols—as well as certain inorganic compounds. Solutions in which these substances are present in low concentration can be sterilized by rotating the flask in such a way that all parts of the solution receive similar amounts of ultraviolet energy. Spectrographic analysis of our three concentrated stock solutions[2] fails to indicate any significant absorption of wave length 2,537 A. to a depth of 1 cm.[3]

[1] This work was supported in part by a grant from the University Research Committee of the University of Alabama.

[2] Solution A: 7 per cent NaCl, 0.2 per cent KCl, 0.2 per cent $CaCl_2$, 0.1 per cent $MgCl_2$, 0.2 per cent NaH_2PO_4; Solution B: 0.12 per cent $NaHCO_3$; Solution C: 8 per cent dextrose. These constituents, if combined in a single concentrated stock solution, will undergo chemical reaction and precipitation after a short storage period. If kept in three separate solutions, however, and stored in a refrigerator, they will remain usable for a long period. Our dilute, ready-to-use solution consists of 1 part of each of Solutions A, B, and C to 7 parts of water.

[3] We are indebted to Mrs. Dorothy C. Peterson, of the National Institute of Health, for this analysis.

In sterilizing physiological salt solutions, ultraviolet radiation has a number of advantages over heat sterilization. First, there is no loss of water through evaporation and no consequent increase in osmotic pressure. Second, heat-induced chemical reactions between the constituents of the different stock solutions, viz., certain inorganic salts and dextrose, are

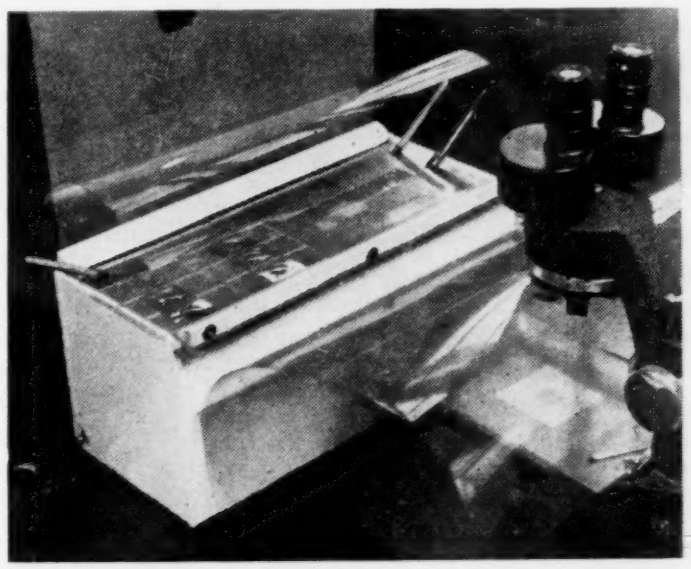

Fig. 1. Exterior of sterilization box, showing dissecting instruments, cover glasses, and slides in position for sterilization.

eliminated; therefore, sterilization can follow mixing and dilution. This dilute solution will remain stable at room temperature for at least several weeks if sterilized with ultraviolet after each opening of the container. Third, unsterilized pipettes

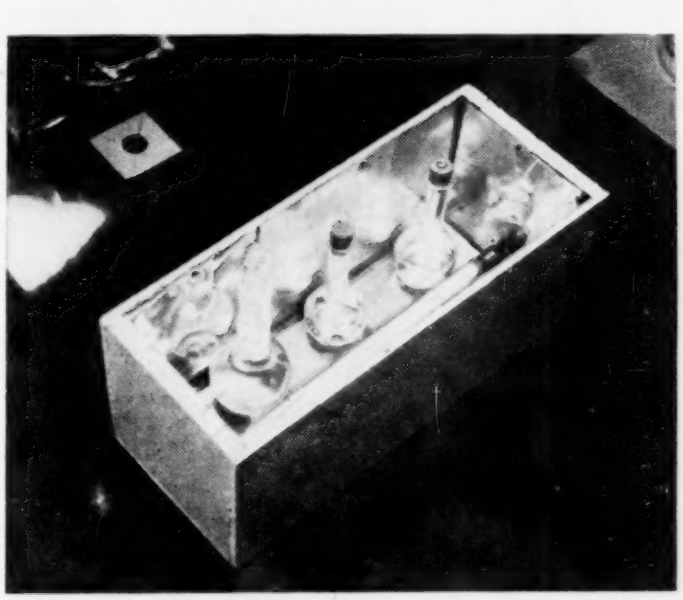

Fig. 2. Interior of sterilization box, showing aluminum lining, ultraviolet lamp, and solutions in quartz flasks.

can be used in making the dilution, for asepsis can be accomplished quickly by subsequent irradiation of the final solution, and the stock solutions can be readily resterilized with ultraviolet after opening. Fourth, the whole method is simpler and less time consuming than autoclaving, irradiation for about 5 minutes being sufficient. It must be remembered, however, that excessive exposure of some substances to ultraviolet produces chemical changes.

Our device is shown in Fig. 1. The transparent shield that covers the box containing the ultraviolet lamp protects the

eyes from direct and scattered radiation. It is a sheet of unexposed, processed X-ray film, which absorbs practically all the 2,537 A. ultraviolet striking it. The aluminum cover of the box has openings for dissecting instruments, cover glasses, and slides. The dissecting instruments are kept sterile by exposure to radiation whenever they are not in use. A few minutes before a set of preparations is to be made, cover glasses and depression slides are inverted over the larger openings.

The interior of the box is shown in Fig. 2. The ultraviolet source is an 8-watt, commercial, low-pressure, mercury vapor lamp, known by the trade name "germicidal lamp" or "sterilamp," with lamp holders, ballast, and starter. The box is lined with aluminum, which is a particularly good reflector of ultraviolet and insures irradiation of all sides of the instruments and of the mouths of cork-stoppered flasks. We have found it necessary to insert a piece of cellophane under the cork stoppers to prevent mold growth on their lower surfaces. Further, since many fused quartz flasks do not have perfectly round mouths and therefore seal with difficulty, the projecting edges of the cellophane help guard against the entrance of contaminants.

Every precaution should be taken to prevent exposure of the eyes of the worker or others in the room to direct or reflected radiation from the lamp. Failure to observe this may result in severe temporary pain commencing several hours after exposure. Unexposed, processed X-ray film, pieces of window glass, and most opaque materials of appreciable thickness are effective absorbers of the harmful radiation.

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The Production of Phenocopies in *Drosophila* Using Visible Light and a Photodynamic Dye

CLAUDE A. VILLEE and GEORGE I. LAVIN

Marine Biological Laboratory, Woods Hole, Massachusetts; Department of Biological Chemistry, Harvard Medical School; and *Rockefeller Institute for Medical Research, New York City*

Phenocopies, changes in development produced experimentally which mimic the phenotypes of mutant genes, have been produced by high temperatures (*5*, *8*), low temperatures (*6*), X-rays (*3*, *9*, *11*), chemical agents (*7*), and ultraviolet rays (*2*, *4*, *10*). The present study was undertaken to see whether phenocopies could be produced by visible light and a photodynamic dye and to explore the possibility of using cyanin as a photodynamic dye. The dyes used previously by other experimenters have the disadvantage of being difficult to remove from the organism treated after their use so that the photodynamic action may continue. Cyanin (quinoline blue) is an indicator dye that is colorless at pH 7 and blue at pH 8, which permits its photodynamic action to be controlled by adjustment of the pH.

Drosophila larvae of known ages were obtained by allowing large numbers of flies to lay eggs for a two-hour period on corn meal-molasses-agar food in half-pint bottles. The cultures were kept at 25.5° C. before and after irradiation. For irradiation, the larvae were placed in small Petri dishes, covered with 0.04 per cent cyanin solution adjusted to pH 8, and exposed to the light from a 100-watt projection lamp at a distance of 10

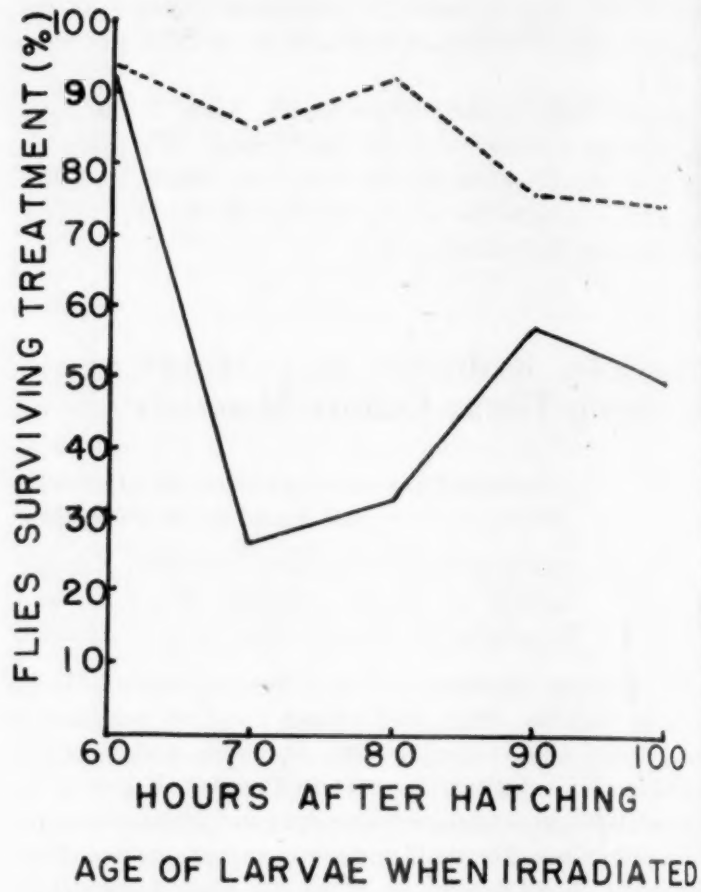

FIG. 1. Percentage of flies hatching from larvae exposed to light in cyanin solution. Dotted line = 30-minute exposure, solid line = 60-minute exposure.

inches. After irradiation the cyanin solution was made colorless by the addition of a few drops of 0.1N HCl, and the larvae removed, washed twice in Ringer's solution, and placed in shell vials in the incubator to complete development. The cyanin solution, made by grinding 0.1 gram of crystalline cyanin (Grübler) in a mortar with 20 cc. of 0.01N NaOH and diluting to 250 cc. with distilled water, is not very stable and gradually loses its blue color.

Larvae 60–100 hours old (after hatching from the egg) were exposed for 30 or 60 minutes to the beam of light. The absolute intensity of the light is not known, but the constancy of its intensity throughout the experiment was checked by a photocell and milliammeter. As a result of the light a certain percentage of the larvae were killed in each experiment (Fig. 1); the larvae usually died within 12 hours of the irradiation, although some died after pupation. Other larvae, placed in the cyanin solution and subjected to the same changes in pH and washings as the irradiated flies, but not irradiated, showed no mortality. A second effect of the light was the production of a certain number of phenocopies: abnormal abdomen, dark eye color, bent or missing bristles, and folded wings (Fig. 2). The various types of phenocopies occurred at random throughout the period tested; no indication was found that an irradiation at a particular stage tended to produce a particular kind

of phenocopy. In all, 558 flies of two stocks, an isogenic wild type and the mutant aristapedia-Bridges, were irradiated. No difference in the response of the two stocks was observed. The results indicate the existence of two periods of high sensitivity to the treatment, one 70 hours after hatching and one 100 hours after hatching, just before pupation. Larvae

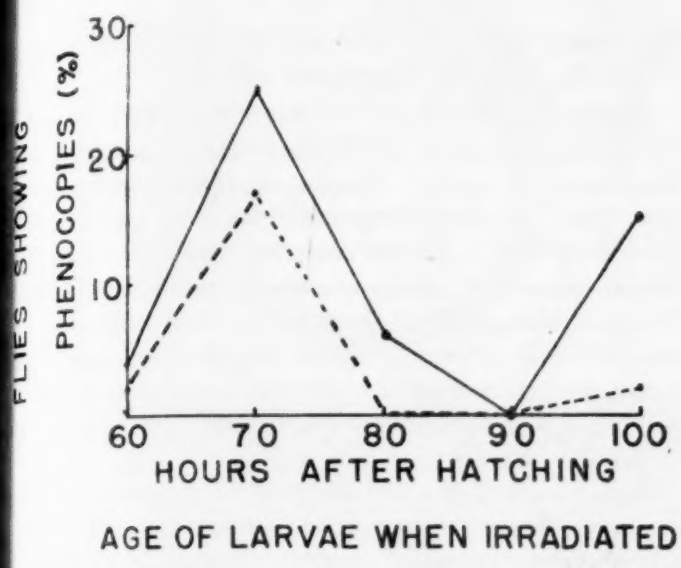

FIG. 2. Percentage of flies showing phenocopies after exposure of the larvae to light in cyanin solution. Dotted line = 30-minute exposure, solid line = 60-minute exposure.

show a gradual increase in sensitivity to ultraviolet radiation with increasing age from 50 to 100 hours after hatching (*10*) but only one period of maximum sensitivity, just before pupation.

The phenocopies produced in these experiments may be interpreted as due to the killing of individual cells or groups of cells in the larvae at the time of the exposure, which results in the failure of some part to form. More extensive damage results in the death of the larva. The larvae which pupated and then died were dissected open. These animals showed patches of black, necrotic tissue on the abdomen which resembled burns. No phenocopies resembling the pervasive changes in morphogenesis found as a result of X-radiation (*9, 11*) were produced by these treatments. Photodynamic dyes are believed (*1*) to be activated by a quantum of light and to transfer this activation to a molecule of some substrate substance in the cell which then reacts with oxygen. Since the oxidation of this substrate molecule is incompatible with life, the cell dies.

These experiments demonstrate the effectiveness of cyanin as a photodynamic dye in the production of phenocopies and suggest its use in other biological systems.

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A Qualitative Test for Penicillin

FREDERICK KAVANAGH

The New York Botanical Garden, New York City

As the list of antibiotic substances lengthens, the problem of determining whether or not a new one has been obtained becomes increasingly difficult. In a survey of new sources of antibiotic substances, the problem is further complicated by the need to identify the active substance in highly impure preparations. The fact that penicillin is widely distributed, very active, and produced in satisfactory quantities by fungi already in cultivation makes it highly desirable to determine before the solution is studied further that its activity is not due to penicillin. An enzyme from a culture of *Staphylococcus aureus*, which did not affect the activity of aspergillic acid, gliotoxin, and gramicidin but did inactivate penicillin, was used to indicate that one of the antibiotic agents formed by *Aspergillus flavus* was a penicillin (*2*).

A specific qualitative test for penicillin is available if it can be shown that penicillinase inactivates only penicillin and does not affect other antibacterial substances. Penicillinase in the form of Clarase Lot No. 1351 and Schenley Penicillinase are used in chemical (*6*) methods for the assay of penicillin concentrates and in sterility tests of penicillin preparations (*1, 4, 5*).

It was found in this laboratory that penicillinase (Clarase Lot No. 1351 or Schenley Penicillinase A) did not affect the antibacterial activity of the following substances: aspergillic acid, citrinin, gliotoxin, patulin, penicillic acid, spinulosin, streptomycin, streptothricin, the active substances formed by eight members of the higher Basidiomycetes, and a crystalline compound isolated from a green plant. The activity of one of the basidiomycete culture solutions was not affected by the Schenley Penicillinase A but was decreased by the Clarase, presumably as the result of some of the many other enzymes in it. Hence, only the Penicillinase A could be used to identify penicillin. It is possible that antibacterial agents other than penicillin will be found that are inactivated by penicillinase; but until they have been shown to occur, the failure to obtain inactivation by penicillinase may safely be taken to indicate the absence of penicillin.

The activities of the antibacterial substances were measured in serial dilution tests (*3*) set up with and without the inactivating enzyme in the broth. The test bacterium was the Heatley strain of *Staph. aureus*. Clarase at a concentration of 1 mg./ml. of broth inactivated 50 μg. of penicillin G in this test—that is, reduced the effective concentration of penicillin to less than 0.06 μg./ml. One Schenley unit of penicillinase/ml. of broth inactivated 200 μg. of penicillin G. The Clarase and Schenley Penicillinase A were used at concentrations sufficient to inactivate penicillin solutions with activities from 10 to 100 times as great as that of the antibacterial substances which were not affected by the enzyme.

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Book Reviews

Patterns of mammalian reproduction. S. A. Asdell. Ithaca, N. Y.: Comstock Publishing Co., 1946. Pp. x + 437. (Illustrated.) $5.00.

This book represents a commendable attempt to abstract and condense within the space of 370 pages the literature on types and variants of mammalian reproduction. It provides an adequate picture of the vast diversity of existing patterns and of the amount of work which has been devoted to investigations in this field. The handy volume contains more or less extensive reports on about 200 species, including representatives of all major taxonomic groups. The more fragmentary and casual information relating to another 700 species is collected in numerous tables.

The species descriptions follow each other in taxonomic order. The material relating to the better-known forms (e.g. rat, rhesus monkey) is arranged under subtitles such as "Reproduction in General," "Histology of the Female Tract," "Physiology of the Female Tract," "The Male," etc. Most phases of the reproductive process are covered, but additional consideration might have been given to the developmental condition of the young at the time of birth. The section on Homo sapiens is unduly short. As a rule, the reporting is conscientious, though occasional errors do occur. For example, the statement, "The male pituitary [in man] has about half the activity of the female. . .," is not sustained by the quoted paper.

Since it is the principal aim of this book to make the data about reproduction easily available, a more standardized procedure of presentation, possibly with classification under a system of numeral indexes, might have been adopted. In its present form the book is not as practical a guide either to facts or to literature as it certainly was intended to become. Thus, only by scanning the entire treatise on the rat will a reader find the references to the cytology and physiology of the hypophysis, which are hidden in the chapters on the female tract.

In the Introduction of 33 pages, Asdell draws a general outline of mammalian reproduction, in which he includes some interesting original interpretations. His discussion bears on topics like sex determination, sexual maturity, hormones in reproduction, estrous cycles, pregnancy, viability of spermatozoa, and functions of male accessory organs.

The terminology shows some hardly justifiable peculiarities, such as the use of "proestrum," "metestrum," etc., concurrent with "estrus"; and the modification of BNA terms, as in the cases of "stratum granulosa" and "cumulus oöphoron."

Special praise is due to the fine quality of composition and printing of this book, which will serve students and research workers as the standard reference work in its field.

EMIL WITSCHI

State University of Iowa

Microcalorimetry. W. Swietoslawski. New York: Reinhold, 1946. Pp. x + 199. (Illustrated.) $4.75.

In the years between the two World Wars, Prof. Swietoslawski and his associates in the Physicochemical Laboratory of the Institute of Technology, Warsaw, made many important contributions to the field of microcalorimetry. It is fitting that his interesting book is the first comprehensive review and discussion of this subject, which is useful in many fields of science. Chemists, biologists, and physicists have helped develop microcalorimetry in order to measure the small amounts of heat accompanying the dilution of electrolytic solutions, the adsorption of gases on solids, the stimulation of isolated nerves, and radioactive changes.

Prof. Swietoslawski first discusses the general problems of accurate temperature control and measurement, stressing the advantage of eliminating uncertain corrections wherever possible by using comparative measurements. Then he deals with specific methods and their applicability. Many American scientists will be most interested in the methods developed in his laboratory in Warsaw, many of which should be more widely known in this country. The critical discussion of the ice calorimeter is founded on firsthand experience. The microthermal measurements of slow processes, based upon analysis of the heating and cooling curves in an isothermal environment, are ingenious and widely applicable.

One typographical error, reappearing in Equations (3) on page 136 and (4) on page 139, may cause the reader brief confusion. In heating or cooling, a thermally active block approaches a convergence temperature, t_a, above that of the thermostat, t_0. At equilibrium the rate of change of temperature with time, τ, is zero and should not be equated to the product of the cooling constant, B, and the difference, $\Delta t = t_a - t_0$. Apparently the equations should read $dt/d\tau = 0$, and $B(t_a - t_0) = B\Delta t = a$, where a is "*the rate at which the block is heated when kept under strictly adiabatic conditions.*"

The discussion of the ingenious labyrinth flow calorimeter warrants study in connection with prolonged thermal changes met in physiological and biological problems, as well as in physical problems, such as the heat effects accompanying the aging of some salts and the deformation, under its own weight, of a suspended sample of lead. This apparatus also has industrial applications to the prolonged thermal changes accompanying the hardening of cements and the aging of alloys.

About 200 articles on microcalorimetry are listed at the end of the book, and frequent reference to this material is made throughout the text. The book should provide scientists in many fields with an excellent introduction to a useful and little-exploited technic.

FRANK T. GUCKER, JR.

Department of Chemistry,
Northwestern University